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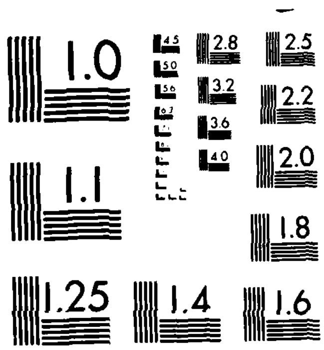

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IGITAL TROPOSCATTER PERFORMANCE MODEL:
SOFTWARE DOCUMENTATION

Contract No. DCA100-80-C-0030
SIGNATRON Reference A288-16

November 1983

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Diffraction	Multipath Prediction
MD-918 Modem	Error Rate Prediction
AN/TRC-170	Link Analysis

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The software program for the analysis and evaluation of digital troposcatter communication links is described. The computer program TROPO is intended to provide an accurate prediction model of the troposcatter and/or diffraction propagation path at frequencies between 100 MHz and 10 GHz for all types of diversity receiver configurations used in the DCS, and the prediction of the performance of the MD-918 and AN/TRC-170 troposcatter modems. The program can also evaluate the performance of other modems if a performance (over)

19. Abstract (Concluded)

prediction model is provided by the user. TROPO takes into account a number of practical factors such as the effects of RF interference, RF bandwidth constraints, actual diversity antenna geometry, climate and atmospheric characteristics. This document describes the various routines and sub-programs that are used to perform the troposcatter and diffraction path loss, multipath and digital troposcatter link performance calculations.

ORIGINATOR - SUPPLIED KEY WORDS INCLUDE:

FOREWORD

This document is the Software Documentation report for contract DCA100-80-C-0030 prepared by SIGNATRON, Inc. for the Defense Communications Agency. It contains a description of the subprograms used in TROPO to model the performance of digital troposcatter systems. The theory and analytical models used in the calculations are given in the User's Manual and Final Report. The subprogram descriptions have been grouped according to the major functions performed.

Table of Contents

CHAPTER 1

INTRODUCTION

This document is the Software Documentation for the Digital Troposcatter Performance Model Computer Program TROPO. The program performs propogation predictions and modem performance predictions based on the models described in the Final Report.

1.1 Report organization

The report is organized into ten chapters documenting each of the TROPO subprograms grouped according to the types of calculations they perform and four appendices containing cross-reference information about TROPO and its output.

Chapter 2, Driver, describes the driver for the TROPO program and includes a top level flowchart of TROPO.

Chapter 3, Input, describes the routines that input data and do preliminary calculations and output of the input variables.

Chapter 4, Error Utilities, describes the preliminary data checking and error handling routines.

Chapter 5, Troposcatter Calculations, describes the routines performing troposcatter calculations.

Chapter 6, Diffraction Calculations, describes the routines performing diffraction calculations.

Chapter 7, Climate Variability Calculations, describes the routines performing climate calculations.

Chapter 8, Butterworth Filter Calculations, describes the routines performing filter calculations.

Chapter 9, MD-918 Modem Calculations, describes the routines performing calculations for the MD-918 modem.

Chapter 10, AN/TRC-170 and DAR Modem calculations, describes the routines performing calculations for the AN/TRC-170 and DAR modem calculations.

Chapter 11, Final output, describes the routine that outputs SUMFAG.OUT and

the routine that outputs the simulator tap values.

Appendix A, PDP Related Information, is for users running the PDP version of TROPO. It cross-references information about the various files in three subsections:

1) Subprogram / Module Reference Index: This lists each subprogram name alphabetically followed by the file it is in.
2) Module / Subprogram Reference Index: This lists each file name alphabetically followed by the subprograms it contains.
3) Common / Include File Reference Index: This lists each common name alphabetically followed by the include file it is in.

Appendix B, Call Cross-Reference, lists which TROPO routines and Fortran functions each subprogram calls as well as which has called the subprogram.

Appendix C, Global Variable Dictionary, defines each global variable, identifies its type and the common it is contained in. In addition, below each variable is a list of which subprograms have used it and which have given it a new value.

Appendix D, Output Variables, defines each variable output to the output files FOR002.DAT and SUMPAG.OUT.

The index alphabetically lists each subprogram and the page it is described on.

1.2 Documentation Structure

The documentation in chapters 2 through 11 has been divided into ten major functions:

1) Driver
2) Data input
3) Data checking
4) Troposcatter calculations
5) Diffraction calculations
6) Climate variability calculations
7) Butterworth filter calculations
8) MD-918 modem calculations
9) AN/TRC-170 and DAR modem calculations
10) Final output

Each subprogram falls into at least one of these sections. In some cases, a routine is used by more than one section. So, if a routine is not in the section you expect, the index can quickly direct you to the right page.

Each subprogram description follows the same form:

	1) Subprogram name:	Subroutine or Function followed by the name of the routine. This does not include calling arguments
	2) Purpose:	Describes the function the routine performs.
*	3) Description:	This is a more extensive description of the routine's function. Also describes coding conventions that you should be aware of, overall coding structure, etc.
*	4) Reference:	Lists outside reference works usually giving a background for and a more in-depth description of the equations used in the code.
	5) Calling sequence:	Variables used in calling the subprogram.
	6) Contained in module:	The name of the source file the subprogram can be found in.
	7) Called by:	Lists which routines call this one.
	8) Calls:	List which routines this one calls. It does not include system routines such as SIN and SQRT or statement functions. Appendix B gives a full listing.
	9) Input arguments:	All values passed to the routine through the calling arguments. This list may overlap the output arguments since some variables may be used for both input and output.
	10) Output arguments:	All values output from the routine through the calling arguments.
*	11) Global variables	All global variables used by the

TSEP(3)	/IODATA/	R*4	IODATA.INC	
	Separation between transmit antennas in meters.			
URH(NR)	/PATHGE/	R*4	TROCOM.INC	
	Array of receive antennas horizontal offsets from great circle plane in meters.			
URL(NR)	/PATHGE/	R*4	TROCOM.INC	
	Array of receive antennas longitudinal offsets in meters.			
URV(NR)	/PATHGE/	R*4	TROCOM.INC	
	Array of receive antennas vertical offsets in meters.			
UTH(NT)	/PATHGE/	R*4	TROCOM.INC	
	Array of transmit antennas horizontal offsets in meters.			
UTL(NT)	/PATHGE/	R*4	TROCOM.INC	
	Array of transmit antennas longitudinal offsets in meters.			
UTV(NT)	/PATHGE/	R*4	TROCOM.INC	
	Array of transmit antennas vertical offsets in meters.			

```
     PI               /CONSTA/        R*4     CONSTANTS.INC
                      Constant Pi = 3.141592654.
     UANGLE           /UNIT/          R*4     IODATA.INC
                      Units of angle (deg, mrad).
     UFREQ            /UNIT/          R*4     IODATA.INC
                      Units of frequency (GHz, MHz).
     UHITE            /UNIT/          R*4     IODATA.INC
                      Units of height and diameter (ft, m).

Global variables output to common:
     AR(NRMX)         /ANTENN/        R*4     TROCOM.INC
                      Array of receiver antenna diameters in meters.  AR(1)
                      is equivalent to RDIAM in the input file.
     AT(NTMX)         /ANTENN/        R*4     TROCOM.INC
                      Array of transmitter antenna diameters in meters.
                      AT(1) is equivalent to TDIAM in the input file.
     IBR(NRMX,NRMX)   /SYSTRN/        I*2     TROCOM.INC
                      Channel complex-envelope correlation and
                      cross-correlation calculation indicator array.
                              0 = No calculation
                              1 = Power (correlation) calculation only
                              2 = Power (correlation) per unit delay
                                  spectrum calculation
     IPOLR(NRMX)      /ANTENN/        I*2     TROCOM.INC
                      Array of receiver antenna polarizations.
     IPOLT(NTMX)      /ANTENN/        I*2     TROCOM.INC
                      Array of transmitter antenna polarizations.
     NR               /SYSTRN/        I*2     TROCOM.INC
                      Number of receive ports.
     NT               /SYSTRN/        I*2     TROCOM.INC
                      Number of transmit ports.
     PHDIV            /MCOM4/         R*4     MCOM.INC
                      Squint angle between upper and lower receiver beams in
                      radians.  Default is beamwidth.
     PSIRAO(NRMX)     /ANTENN/        R*4     TROCOM.INC
                      Array of receiver beam azimuths in radians.
     PSIREO(NRMX)     /ANTENN/        R*4     TROCOM.INC
                      Array of receiver beam boresight elevations above
                      radio horizon in radians, ie, angle at which each
                      antenna is aimed relative to the horizon.  PSIREO(1)
                      is the main receive antenna.
     PSITAO(NTMX)     /ANTENN/        R*4     TROCOM.INC
                      Array of transmitter beam azimuths in radians.
     PSITEO(NTMX)     /ANTENN/        R*4     TROCOM.INC
                      Array of transmitter beam boresight elevations above
                      radio horizon in radians, ie, angle at which each
                      antenna is aimed relative to the horizon.  PSITEO(1)
                      is the main transmit antenna.
     RSEP(3)          /IODATA/        R*4     IODATA.INC
                      Separation between receive antennas.
```

3.1 ANTGEO

Subprogram name: Subroutine ANTGEO

Purpose: Compute antenna geometry parameters for chosen diversity configuration (DIVTYP).

Calling sequence:
CALL ANTGEO (BWR, BWT, HR, HT)

Contained in module: ANTGEO

Called by: INDATA

Calls: NONE

Input arguments:

HR	R*4	Receiver antenna height above ground.
HT	R*4	Transmitter antenna height above ground.

Output arguments:

BWR	R*4	Receiver antenna beamwidth in degrees.
BWT	R*4	Transmitter antenna beamwidth in degrees.

Global variables input from common:

```
ACALC      /IODATA/      L*4    IODATA.INC
           TRUE if the angles PSITEO and PSIREO are calculated
           rather than read in.
CMTPFT     /CONSTA/      R*4    CONSTANTS.INC
           Meters per foot = 0.3048.
DIVTYP     /MCOM2/       I*2    MCOM.INC
           Diversity configuration indicator.  Default is 0.
            0 = 2 receive antennas; 2S    2S/2F    2S/2A 2S/2A/2F
            1 = 1 receive antenna;  2A    2F       2F/2A
            2 = 2 transmit,
                2 receive antennas; 2S/2P 2S/2P/2A
            3 = Not used
            4 = User supplied parameters
           S = Space  F = Frequency  A = Angle  P = Polarization
F          /SYSTRN/      R*4    TROCOM.INC
           Operating frequency in Hz.  Model is accurate between
           100MHz and 10GHz.
LERR       /LUNS/        I*2    LUNS.INC
           Error output unit.
MET        /UNIT/        R*4    IODATA.INC
           String 'met ' for units output.
MHZ        /UNIT/        R*4    IODATA.INC
           String 'MHz ' for units output.
MRADNS     /UNIT/        R*4    IODATA.INC
           String 'mrad' for units output.
```

CHAPTER 3

INPUT

This section describes the initial data handling routines:

Name	Description	User's Manual section
ANTGEO	Antenna geometry	NA
ERRIO	I/O Error message output . . .	2.3, 3.4.3
INDATA	Data input	2.2, 3.2
OUTDAT	Output summary of input data .	3.4.1
SECTOR	Sector search	NA
UNITCV	Units conversion	2.2
UNITS	Units decoding/encoding	NA

The main routine for this section is INDATA.

All data input to TROPO comes from the input file, TROPO.DAT, on unit LIN. A complete description of this file can be found in the User's Manual, section 3.2. OUTDAT writes into the file FOR002.DAT on unit LOUT, which is described in section 3.4.1 of the User's Manual.

NOTE

In most cases the sections in the User's Manual describe the coded equations as well as the theory behind them. NA denotes routines that are programming utilities such as finding indices, setting pointers, etc.

Control indicator for entry or calculation of transmit/receive radio horizon angles THET and THER. Values have following meanings:

0 = Use input THET, THER as reference and actual horizon (default).
1 = Calculate reference horizon using HORANG and K equals 1.33. (Assuming DLT and DLR are non-zero.) (Option not available.)
2 = Calculate reference horizon using HORANG and K equals ERFAC. (Assuming DLT and DLR are non-zero.)
3 = Do not change reference horizons from previous run. (Option not available.)

SEAN /PROPAR/ R*4 TROCOM.INC

Minimum monthly median of refractivity at sea level. Used to calculate ERFAC if non-zero.

```
                          For DIVTYP = 2:
                             Q(.,1)  Power on path 1 (lower beam) vs. delay.
                             Q(.,2)  Correlation between convergent paths
                                     (lower beam) vs. delay.
                             Q(.,3)  Correlation between divergent paths
                                     (lower beam) vs. delay.
                             Q(.,4)  Correlation between parallel paths
                                     (lower beam) vs. delay.
                             Q(.,5)  Correlation between crossing paths
                                     (lower beam) vs. delay.
                             Q(.,6)  Power on path of upper beam vs. delay.
                             Q(.,7)  Power on diffraction path vs. delay.
     STSNR               /SUMP/           R*4     SUMP.INC
                          Standard deviation of troposcatter signal long-term
                          SNR distribution in dB.
     TAPW                /MCOM4/          R*4     MCOM.INC
                          Normalized tapwidth for MD-918.  Default is .5.
                          Range is 0.25 through 1.0
     TEMPA(NCORMX)       /PDATA/          R*4     PDATA.INC
                          Array of average troposcatter signal delays for each
                          beam relative to straight line in seconds.
     TERFAC(3)           /ERAD/           R*4     ERAD.INC
                          The three values of ERFAC when MDIST is 1.
     THER                /PATHGE/         R*4     TROCOM.INC
                          Radio horizon elevation angle at receive site in
                          radians.
     THET                /PATHGE/         R*4     TROCOM.INC
                          Radio horizon elevation angle at transmit site in
                          radians.
     TODAY(9)            /TSTAMP/         L*1     IODATA.INC
                          Array used in PDP-11 version to hold date as
                          characters.

Global variables output to common:
     DELPBZ              /RZ1/            R*4
                          Resolution of a delay cell in seconds.  Same as DELPB
                          in /PDATA/.
     DELTAR(NRMX)        /ANTENN/         R*4     TROCOM.INC
                          3dB half-beamwidth of each receive antenna in radians.
     DELTAT(NTMX)        /ANTENN/         R*4     TROCOM.INC
                          3dB half-beamwidth of each transmit antenna in
                          radians.
     ERFAC               /PROPAR/         R*4     TROCOM.INC
                          Yearly median value of effective earth radius factor k
                          in kilometers.  Default is 1.33.
     GRDB(NRMX)          /ANTENN/         R*4     TROCOM.INC
                          Gain of each receive antenna in dBi.
     GTDB(NTMX)          /ANTENN/         R*4     TROCOM.INC
                          Gain of each transmit antenna in dBi.
     ITOFF               /PROPAR/         I*2     TROCOM.INC
```

```
MODPAT          /MCOM2/        I*2     MCOM.INC
                Propagation/modem flag to select calculation mode.
                Default is 1.
                        0 = Propagation only
                        1 = Propagation + MD-918 modem
                        2 = Propagation + AN/TRC-170 or DAR modem
                        3 = Propagation + user-defined modem
MODSIG          /MCOM2/        I*2     MCOM.INC
                Interference signal modulation format.  Default is 1.
                        0 = Analog FDM / FM
                        1 = Digital QPSK
MRAD            /ERAD/         I*2     ERAD.INC
                Loop limit for MRAD. Default is 1.
                (MRAD is 1 for MDIST = 0 and MRAD is 3 for MDIST = 1).
NERT            /MCOM2/        I*2     MCOM.INC
                Bit error rate threshold indicator for yearly fade
                outage probability calculation.  Default is 2.
                        0 = All three thresholds
                        1 = For 10**(-3) only
                        2 = For 10**(-4) only
                        3 = For 10**(-5) only
NOBS            /MCOM2/        I*2     MCOM.INC
                Number of diffraction obstacles. Maximum is 3,
                default is 1.
NOW(8)          /TSTAMP/       L*1     IODATA.INC
                Array used in PDP-11/70 version to hold time of day as
                characters.
NR              /SYSTRN/       I*2     TROCOM.INC
                Number of receive ports.
NRAD            /ERAD/         I*2     ERAD.INC
                ERFAC indicator and loop counter.  Default is 1.
NT              /SYSTRN/       I*2     TROCOM.INC
                Number of transmit ports.
Q(NDELMX,NCORMX) /PDATA/       R*4     PDATA.INC
                Matrix of troposcatter signal power and correlation
                per unit delay profiles.
                For DIVTYP = 0:
                   Q(.,1)  Power on lower beam vs. delay.
                   Q(.,2)  Correlation between lower and
                           upper beam vs. delay.
                   Q(.,3)  Correlation between lower beams
                           in antennas 1 & 2 vs. delay.
                   Q(.,4)  Power on upper beam vs. delay.
                   Q(.,7)  Power on diffraction path vs. delay
                For DIVTYP = 1:
                   Q(.,1)  Power on lower beam vs. delay.
                   Q(.,2)  Correlation between lower and
                           upper beam vs. delay.
                   Q(.,3)  Power on upper beam vs. delay
                   Q(.,7)  Power on diffraction path vs. delay.
```

A	/PATHGE/	R*4	TROCOM.INC	Effective earth radius in meters.
AA	/PROPAR/	R*4	TROCOM.INC	Atmospheric absorption loss in dB.
BW	/SYSTRN/	R*4	TROCOM.INC	Bandwidth in Hertz. Default is 7 MHz.
D	/PATHGE/	R*4	TROCOM.INC	Great circle distance between transmitter and receiver measured at sea level in meters.
DEL	/SUMP/	R*4	CURVE.INC	Diffraction path delay relative to a straight line path in seconds.
DELPB	/PDATA/	R*4	PDATA.INC	Resolution of a delay cell in seconds.
DL(3)	/MCOM4/	R*4	MCOM.INC	Array containing distance from each obstacle to transmitter in meters.
DRATE	/MCOM4/	R*4	MCOM.INC	Data rate in bits/second. Default is 6.6E6.
DS(3)	/MCOM4/	R*4	MCOM.INC	Array of effective obstacle extents along the great circle path in meters.
EOF	/CONTRL/	L*4	TROCOM.INC	End of TROPO.DAT file found if TRUE.
F	/SYSTRN/	R*4	TROCOM.INC	Operating frequency in Hz. Model is accurate between 100MHz and 10GHz.
HL(3)	/MCOM4/	R*4	MCOM.INC	Array containing elevation of each obstacle above sea level in meters. HL(1) is elevation of transmitter radio horizon HLT. HL(NOBS) is elevation of receiver radio horizon HLR.
HRN	/PATHGE/	R*4	TROCOM.INC	Receive antenna height above sea level in meters.
HTN	/PATHGE/	R*4	TROCOM.INC	Transmit antenna height above sea level in meters.
IBW	/MCOM2/	I*2	MCOM.INC	Switch indicating type of RF bandwidth constraint to be used on desired signal. Default is 0. 0 = No RF filtering 1 = Filter determined from 99% bandwidth constraint 2 = Filter chosen to meet FCC Mask. (FCC-19311) 3 = Filters are user specified
LOUT	/LUNS/	I*2	LUNS.INC	FOR002.DAT output unit number.
MDIST	/ERAD/	I*2	ERAD.INC	Multipath distribution indicator. 0 = Only median multipath spread used(default) 1 = Multipath distribution used. (Option not currently available.)

2.1 TROPO

Program name: Program TROPO

Purpose: To predict single link digital troposcatter communications system performance for frequencies between 100 Mhz and 10 Ghz.

Description: The routines in TROPO can be grouped into eight major functions:

1) Data input and unit conversion: INDATA.
2) Data checking and error handling: CHKDAT.
3) Troposcatter propagation calculations: ATMOS, TRANSF, ANTPAR, INTLIM, LTCORR, LOOPS and POWER.
4) Diffraction propagation calculations: MDIF and DIFSNR.
5) Transmitter and receiver filter calculations: BUTFIL.
6) MD-918 modem performance calculations: MDTS.
7) AN/TRC-170 and DAR modem performance calculations: TRCIN.
8) Summary page output: SUMPAG.

The program can perform one of the following functions for each run:

1) Troposcatter calculations only
2) Troposcatter and diffraction calculations
3) Troposcatter and interference calculations
4) Propagation (one of above 3) + MD-918 modem
5) Propagation + AN/TRC-170 or DAR modem
6) Propagation + user defined modem

The input files used are:

Unit no.	File name	Description
LIN = 1	TROPO.DAT	The input file.

The output files used are:

LOUT = 2	FOR002.DAT	The output file.
LERR = 2	FOR002.DAT	The error output file.
LDEBUG = 2	FOR002.DAT	The (debug) output file.
LSUM = 3	SUMPAG.OUT	The summary page file.
LTERM = 4	<user's terminal>	Error messages.

CALL TROPO

Contained in module: TROPO

Calls:

ANTPAR ATMOS BUTFIL CHKDAT DIFSNR INDATA INTLIM LOOPS LTCORR
MDIF MDTS POWER SUMPAG TRANSF TRCIN

Global variables input from common:

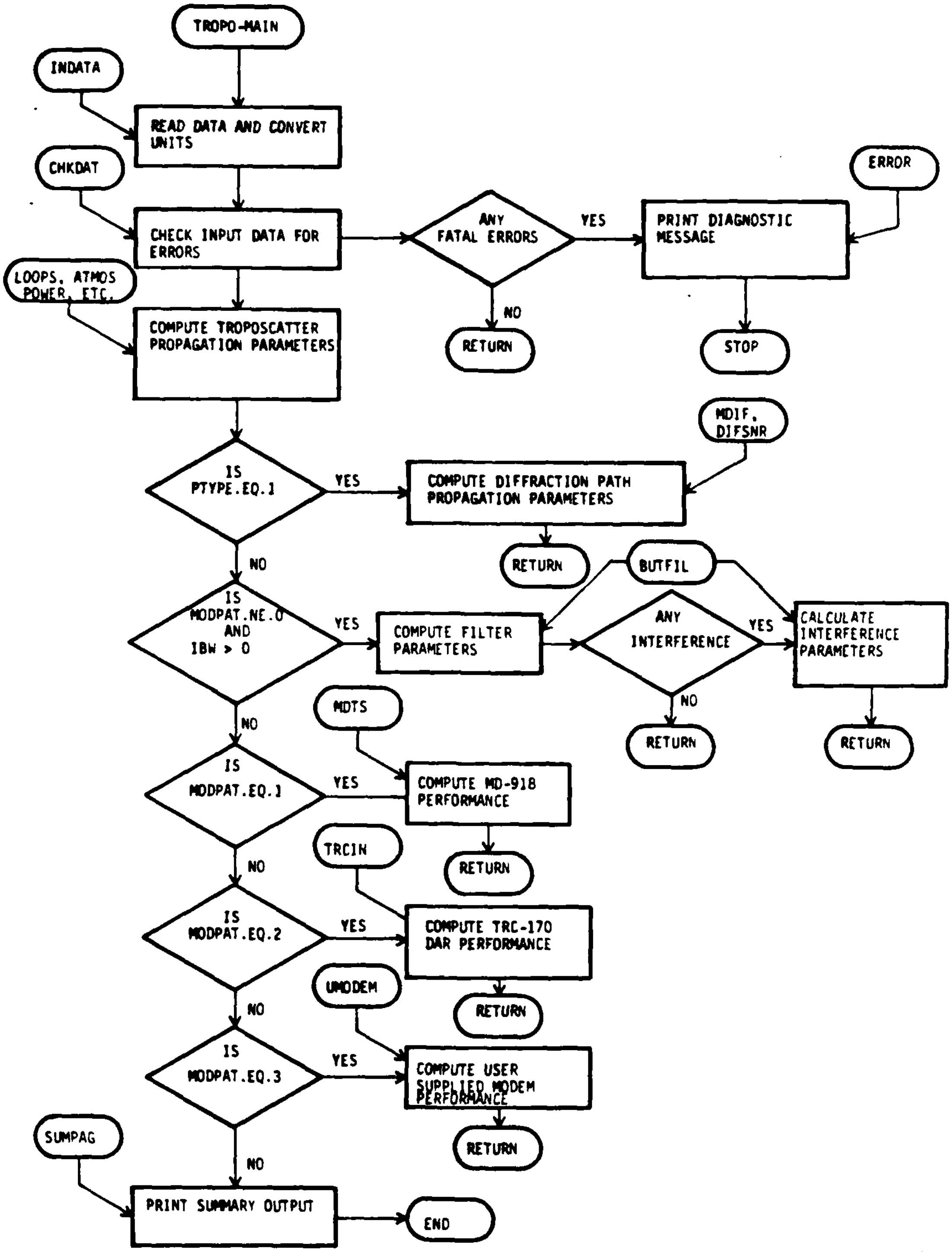


Figure 2-1 Top Level Functional Flow Chart for TROPO Program Calculations

CHAPTER 2

DRIVER

This section describes the driver for the TROPO program. Figure 2-1 is a top level flowchart of the TROPO program at a functional level. In most cases the blocks correspond to one or more subprograms. The test blocks (diamonds), except for 'Any Fatal Errors', correspond to logical branches which are decided by the user's choices of input data.

PDP version	IBM version	Affects (among others)
PARAMETER	Actual numbers used	TROPAR.INC, TROCOM.INC and DATAINIT.FTN
INCLUDE	Commons already included	Any routine accessing a common
BYTE	LOGICAL*1 data type	Various routines
Leading tab	5 or 6 spaces	All routines
Blank lines	'C' before line	All routines
Separate source files	All sources in 1 file	NA
DATE and TIME	No date and time for output	TROPO, OUTDAT, and SUMPAG
No RETURN in block data	RETURN at end	DATAINIT.FTN

Certain FORTRAN compromises have been made in the code to satisfy FORTRAN-H Extended which are acceptable to, though not optimal for, FORTRAN-IV PLUS:

1) IBM does not allow INTEGER*2 variables as arguments to FORTRAN functions which require integer arguments so that INTEGER*4 variables have been used as arguments in such cases.
2) The functions of MIN and MAX have been re-coded in some cases as an alternative to such FORTRAN function calls.
3) The logical unit numbers, LOUT, LIN, etc., are INTEGER*4.
4) The variables in common are listed in decreasing storage size.
5) Data for each common is initialized in block data only.
6) Quoted literals are only used in data statements.
7) Arithmetic expressions were not used in WRITEs, GOTOs and DO loops.
8) Logical variables are LOGICAL*1 or LOGICAL*4 rather than LOGICAL*2.

The error output file, logical unit LERR, is assigned the same unit number as the output file. This can be changed to a unique number so that the errors are written to a separate file. Note that for the PDP version this would also involve changing the task build command file to increase the number of active files (ACTFIL =) and the largest LUN accessed (UNITS =). Your system manual will have more information on this. Be aware that this will also increase the size of the task.

Logical unit LSUM is explicitly assigned to the file SUMPAG.OUT by the OPEN statement in subroutine SUMPAG.

Output to the terminal is done on logical unit LTERM which has been set to 4. The default for the terminal is 5 but in order to reduce task size it has been assigned to unit 4 in the task build command file. Note that this assignment can be changed to the system disk if TROPO is to be run in background and as such cannot access the terminal. If the disk is used, a file, FOR004.DAT, will be opened for the error messages normally sent to the terminal. Another option is to set LTERM to the same value as LERR in the block data section to have the messages in the same file.

1.5 PDP and IBM coding differences

Throughout this document PDP and IBM refer to versions of the program and not necessarily the computer it is running on. The PDP version was written using many of the features of PDP Fortran that allow SIGNATRON to revise the program easily. The IBM version is more universal since it is closer to ANSI Fortran, which allows it to run on other systems with fewer modifications. The following features are different in the source codes of the two versions:

```
            input from common:  routine but not given a new
                                value.

      * 12) Global variables    All global variables possibly
            output to common:   given a new value by the
                                routine.
```

All sections of the description, except those marked by a '*', are always present in all routine descriptions whether data follows the section or not.

1.3 Fortran IV-PLUS

TROPO is written in Fortran IV-PLUS; therefore, it is necessary that the program link to the Fortran IV-PLUS library. Though it is possible to compile and run under Fortan-77, the output is not guaranteed since Fortran-77 is not a strict superset of Fortran IV-PLUS and the differences in the versions may change the results.

1.4 Input and output units

The logical units the TROPO program reads from and writes to files whose associated logical unit numbers are variables passed through the common /LUNS/ in file LUNS.INC. The values are set in the block data section to:

Name	LUN	Purpose	File name
LIN	1	Input file	TROPO.DAT
LOUT	2	Output file	FOR002.DAT
LDEBUG	2	Output file	FOR002.DAT
LERR	2	Error file	FOR002.DAT
LSUM	3	Summary page	SUMPAG.OUT
LTERM	4	Error messages	<user's terminal>

Logical unit LIN is explicitly assigned to the file TROPO.DAT by the OPEN statement in subroutine INDATA.

LOUT is implicitly assigned to the file FOR002.DAT. The PDP-11/70 will assign the default name FOR00n.DAT to any file written to or read from on logical unit n which has not been opened previous to the read or write.

LDEBUG is always assigned to the output file and is present only to distinguish debug write statements from output write statements.

3.2 ERRIO

Subprogram name: Subroutine ERRIO

Purpose: Outputs error number and error message to terminal (unit LTERM) and the output file FOR002.DAT (unit LOUT).

Description: Checking for input errors is done throughout TROPO but the messages written from this routine are for initial testing done in the input routines, INDATA, SECTOR, and UNITS. When a fatal error or data inconsistency is found, processing transfers to this subroutine. Most errors found are fatal so processing branches to line 500 to STOP after outputting the message; others are merely warnings and branch to 600 to return to the calling program and continue processing.

The errors are divided in the source code by calling routine so a check of the code or FORMAT statements reveals in which routine the error was encountered.

Note that for all error 999s the calling program has already printed an error message to the output file FOR002.DAT before calling ERRIO.

Calling sequence:
CALL ERRIO (I)

Contained in module: ERRIO

Called by: INDATA SECTOR UNITS

Calls: NONE

Input arguments:

I	I*2	Error number.

Output arguments:
NONE

Global variables input from common:

LOUT	/LUNS/	I*2	LUNS.INC
	FOR002.DAT output unit number.		

3.3 INDATA

Subprogram name: Subroutine INDATA

Purpose: This subroutine reads the data required for TROPO calculations from the input file TROPO.DAT.

Description: Each section in the source code of INDATA is identified by dashed lines around a section header which correspond with each section in the input file, TROPO.DAT.

There are three types of lines in the input file TROPO.DAT:

1) Sector header
2) Comment
3) Data

A sector header identifies the beginning of each section. Before INDATA reads a section of data, SECTOR searches for the sector header by reading lines until the first four letters match the section wanted. This feature makes the data in each section independent which is necessary when, for exalpe, PTYPE = 0. In this case, INDATA reads in all the TROPOSCATTER data. The next section, DIFFRACTION, is only needed for PTYPE = 1. Since it contains data for some of the same variables just initialized, in order to preserve these values, SECTOR is called to search for the DIFFRACTION sector header which skips over these data lines. From this point INDATA goes on to read the diversity data.

A comment line describes the data that should follow, giving defaults and maximums in some cases. Each begins with a '*' to differentiate these lines from the sector headers. In the code, the statement: READ (LIN,1005) skips over the comment lines in the input file. The number of these reads corresponds to the number of comment lines preceding each data line in the input file.

Most data lines are read in list-directed. This type of read will read digits into the variable until a delimeter (space or comma) is found, eliminating the need for data to be lined up in specific columns as in formatted input. The data type is converted on input to the variable type so that integers may be input for reals. Two consecutive commas (or a leading or trailing comma) inputs no data into the corresponding variable, thus preserving its default value. A slash terminates input for all remaining items in the input list, also preserving their default values. Note, the slash cannot be used for logical or literal data.

Literal data is, in most cases, read into REAL*4 variables with an alpha format descriptor (of the form A[w]). This will put one character into each of the four bytes of the real as though it were a BYTE (LOGICAL*1) array of length four.

CAUTION! When adding new variables to the input file, do not insert them before the units section (HDU, ANGU, etc.) if the data is to be converted by UNITCV to and from MKS units. In subsequent runs, the call to UNITCV comes immediately after these units are deciphered so all values in common are treated as though in MKS units.

Calling sequence:
CALL INDATA (JPOW,ASEP,CLIMAT,BWT,BWR,PTYPE, JBW,TRCTYP,FJSEP)

Contained in module: INDATA

Called by: TROPO

Calls: ANTGEO ERRIO OUTDAT SECTOR UNITS

Input arguments:
NONE

Output arguments:

JPOW	R*8	Interference signal power density in dBm/Hz.
ASEP	R*4	Separation between receive antennas in meters.
CLIMAT	R*4	Climate zone indicator.
BWT	R*4	Transmit antenna beamwidth in degrees.
BWR	R*4	Receive antenna beamwidth in degrees.
PTYPE	I*2	Variable which indicates whether propagation mechanism is pure troposcatter (0 or 10) or mixed troposcatter-diffraction (1 or 11).
JBW	R*8	Interfering signal bandwidth in Hz.
TRCTYP	R*4	TRC-170 modem type indicator: 0 = 1 frequency DAR modem 1 = 2 frequency AN/TRC-170
FJSEP	R*4	Frequency separation between desired signal and interference signal in Hertz.

Global variables input from common:

A0	/CONSTA/	R*4	CONSTANTS.INC
	Radius of the earth in meters = 6367650.		
C0	/CONSTA/	R*4	CONSTANTS.INC
	Free space velocity of radio waves = 2.998E8 m/sec.		
CMTPFT	/CONSTA/	R*4	CONSTANTS.INC
	Meters per foot = 0.3048.		
GHZ	/UNIT/	R*4	IODATA.INC
	String 'GHz ' for units output.		
KM	/UNIT/	R*4	IODATA.INC
	String 'km ' for units output.		
LERR	/LUNS/	I*2	LUNS.INC
	Error output unit.		
MDIST	/ERAD/	I*2	ERAD.INC

```
                         Multipath distribution indicator.
                                0 = Only median multipath spread used(default)
                                1 = Multipath distribution used.  (Option not
                                    currently available.)
       MHZ               /UNIT/          R*4    IODATA.INC
                         String 'MHz ' for units output.
       UDIST             /UNIT/          R*4    IODATA.INC
                         Units of distance (smi, nmi, km).
       UFREQ             /UNIT/          R*4    IODATA.INC
                         Units of frequency (GHz, MHz).

   Global variables output to common:
       A                 /PATHGE/        R*4    TROCOM.INC
                         Effective earth radius in meters.
       ACALC             /IODATA/        L*4    IODATA.INC
                         TRUE if the angles PSITEO and PSIREO are calculated
                         rather than read in.
       AR(NRMX)          /ANTENN/        R*4    TROCOM.INC
                         Array of receiver antenna diameters in meters.  AR(1)
                         is equivalent to RDIAM in the input file.
       AT(NTMX)          /ANTENN/        R*4    TROCOM.INC
                         Array of transmitter antenna diameters in meters.
                         AT(1) is equivalent to TDIAM in the input file.
       AVERX             /MCOM4/         R*4    MCOM.INC
                         Average terrain elevation above sea level between
                         receive site and radio horizon, in meters.
       AVETX             /MCOM4/         R*4    MCOM.INC
                         Average terrain elevation above sea level between
                         transmit site and radio horizon, in meters.
       BW                /SYSTRN/        R*4    TROCOM.INC
                         Bandwidth in Hertz.  Default is 7 MHz.
       CHGHR             /IODATA/        L*4    IODATA.INC
                         HR set to AR(1) if TRUE.
       CHGHRE            /IODATA/        L*4    IODATA.INC
                         HRE set to HR if TRUE.
       CHGHT             /IODATA/        L*4    IODATA.INC
                         HT set to AT(1) if TRUE.
       CHGHTE            /IODATA/        L*4    IODATA.INC
                         HTE set to HT if TRUE.
       CN2(NPROF)        /PROPAR/        R*4    TROCOM.INC
                         The atmospheric structure constant height profile in
                         meters to the -2/3 power.
       CODE              /MCOM4/         L*4    MCOM.INC
                         Flag for coding.
       D                 /PATHGE/        R*4    TROCOM.INC
                         Great circle distance between transmitter and receiver
                         measured at sea level in meters.
       DELH              /PROPAR/        R*4    TROCOM.INC
                         Spacing of CN2 samples in meters.
       DEMIN             /CURVE/         R*4    CURVE.INC
```

User supplied minima of the 90th percentile variability curve, Y0(90).

DIVTYP	/MCOM2/	I*2	MCOM.INC	

Diversity configuration indicator. Default is 0.
- 0 = 2 receive antennas; 2S 2S/2F 2S/2A 2S/2A/2F
- 1 = 1 receive antenna; 2A 2F 2F/2A
- 2 = 2 transmit, 2 receive antennas; 2S/2P 2S/2P/2A
- 3 = Not used
- 4 = User supplied parameters

S = Space F = Frequency A = Angle P = Polarization

DL(3) /MCOM4/ R*4 MCOM.INC
Array containing distance from each obstacle to transmitter in meters.

DLR /PATHGE/ R*4 TROCOM.INC
Distance from receiver to radio horizon in meters.

DLT /PATHGE/ R*4 TROCOM.INC
Distance from transmitter to radio horizon in meters.

DRATE /MCOM4/ R*4 MCOM.INC
Data rate in bits/second. Default is 6.6E6.

DS(3) /MCOM4/ R*4 MCOM.INC
Array of effective obstacle extents along the great circle path in meters.

ELANG(10) /MCOM4/ R*4 MCOM.INC
Interferer elevation angles in degrees. Default is 0.

EOF /CONTRL/ L*4 TROCOM.INC
End of TROPO.DAT file found if TRUE.

ERFAC /PROPAR/ R*4 TROCOM.INC
Yearly median value of effective earth radius factor k in kilometers. Default is 1.33.

ERR /CONTROL/ R*4 TROCOM.INC
Common volume integration resolution. Default is .001.

F /SYSTRN/ R*4 TROCOM.INC
Operating frequency in Hz. Model is accurate between 100MHz and 10GHz.

FCRX /BUTPAR/ R*4 BUTPAR.INC
Normalized 3dB cut-off frequency of receiver filter.

FCTX /BUTPAR/ R*4 BUTPAR.INC
Normalized 3dB cut-off frequency of transmitter filter.

GPF /CURVE/ R*4 CURVE.INC
Frequency correction factor for user supplied 90th percentile variability curve. Default is 1.

HI(155) /MCOM4/ R*4 MCOM.INC
Array containing NPM(1) evenly-spaced terrain elevation data (in meters) between transmitter and first obstacle followed by NPM(2) evenly-spaced terrain elevation data between first and second obstacle, etc., ending with NPM(NOBS+1) evenly-spaced terrain elevation data between last obstacle and

receive site. The data should be selected such that:
HI(1) = Terrain elevation above sea level at transmit site (HTO).
HI(NPM(I)) = HI (NPM(I)+1) = Elevation of Ith obstacle above sea level (HL(I)).
HI(NPM(NOBS+1)) = Terrain elevation above sea level at receive site (HRO).
In MOTS, HI is used as work space. It is equivalenced to local arrays.

HL(3) /MCOM4/ R*4 MCOM.INC
Array containing elevation of each obstacle above sea level in meters. HL(1) is elevation of transmitter radio horizon HLT. HL(NOBS) is elevation of receiver radio horizon HLR.

HLAV(3) /MCOM4/ R*4 MCOM.INC
Array containing average terrain elevation at each diffraction point in meters.

HLEF(3) /MCOM4/ R*4 MCOM.INC
Array containing effective height of obstacles above average terrain elevation in meters.

HLOW /PROPAR/ R*4 TROCOM.INC
Lowest height above sea level at which CN2 is specified in meters.

HLR /PATHGE/ R*4 TROCOM.INC
Receiver radio horizon elevation above sea level in meters.

HLT /PATHGE/ R*4 TROCOM.INC
Transmit radio horizon elevation above sea level in meters.

HRE /MCOM4/ R*4 MCOM.INC
Effective receiver antenna height above average terrain elevation in meters.

HRN /PATHGE/ R*4 TROCOM.INC
Receive antenna height above sea level in meters.

HTE /MCOM4/ R*4 MCOM.INC
Effective transmitter antenna height above average terrain elevation in meters.

HTN /PATHGE/ R*4 TROCOM.INC
Transmit antenna height above sea level in meters.

IBR(NRMX,NRMX) /SYSTRN/ I*2 TROCOM.INC
Channel complex-envelope correlation and cross-correlation calculation indicator array.
0 = No calculation
1 = Power (correlation) calculation only
2 = Power (correlation) per unit delay spectrum calculation

IBW /MCOM2/ I*2 MCOM.INC
Switch indicating type of RF bandwidth constraint to be used on desired signal. Default is 0.
0 = No RF filtering

```
                         1 = Filter determined from 99% bandwidth constraint
                         2 = Filter chosen to meet FCC Mask.  (FCC-19311)
                         3 = Filters are user specified
ICLIME                /MCOM2/         I*2     MCOM.INC
                      Climate class.  Default is 0.
                         0 = NBS TN-101 climate
                         1 = MIL-HDBK-417 climate
                         2 = New, user-supplied climate
IFILRX                /BUTPAR/        I*2     BUTPAR.INC
                      Receiver filter indicator.
                              0 = MD-918 receiver filter.  Also means
                                  filter is a Butterworth cascaded with a
                                  rectangular impulse response filter of
                                  duration equal to symbol duration.
                              1 = (not allowed)
                              2 = AN/TRC-170 receiver filter.  Also means
                                  filter is a Butterworth.
IFILTX                /BUTPAR/        I*2     BUTPAR.INC
                      Transmitter filter indicator.
                              0 = MD-918 transmitter filter.  Also means
                                  filter is a Butterworth cascaded with a
                                  rectangular impulse response filter of
                                  duration equal to symbol duration.
                              1 = AN/TRC-170 transmitter filter.  Also means
                                  filter is a cascade of Butterworth filter
                                  with rectangular impulse response filter
                                  of duration equal to half symbol duration.
                              2 = (not allowed)
IOPEND                /CONTRL/        I*2     TROCOM.INC
                      Number of output files opened.
IPOLR(NRMX)           /ANTENN/        I*2     TROCOM.INC
                      Array of receiver antenna polarizations.
IPOLT(NTMX)           /ANTENN/        I*2     TROCOM.INC
                      Array of transmitter antenna polarizations.
ITOFF                 /PROPAR/        I*2     TROCOM.INC
                      Control indicator for entry or calculation of
                      transmit/receive radio horizon angles THET and THER.
                      Values have following meanings:
                              0 = Use input THET, THER as reference and
                                  actual horizon (default).
                              1 = Calculate reference horizon using HORANG
                                  and K equals 1.33.  (Assuming DLT and DLR
                                  are non-zero.)  (Option not available.)
                              2 = Calculate reference horizon using HORANG
                                  and K equals ERFAC.  (Assuming DLT and DLR
                                  are non-zero.)
                              3 = Do not change reference horizons from
                                  previous run.  (Option not available.)
KLIMAT                /PROPAR/        I*2     TROCOM.INC
                      Climate zone indicator.  Default is 0.
```

```
                              0 = User supplied climate
                       NBS TN101 climates
                              1 = Continental temperate (CT)
                              2 = Maritime temperate overland (MTL)
                              3 = Maritime temperate oversea (MTS)
                              4 = Maritime subtropical overland (MSL)
                              5 = Continental temperate time block 2 (CT2)
                                  (winter afternoon hours) - formerly
                                  Maritime subtropical oversea (MSS)
                              6 = Desert, Sahara (DS)
                              7 = Equatorial (EQU)
                              8 = Continental subtropical (CS)
                       MIL-HDBK-417 climates
                              9 = Continental temperate (CT)
                              10 = Maritime temperate overland (MTL)
                              11 = Maritime temperate oversea (MTS)
                              12 = Maritime subtropical (MS)
                              13 = Desert, Sahara (DS)
                              14 = Equatorial (EQU)
                              15 = Continental subtropical (CS)
                              16 = Mediterranean (MED)
                              17 = Polar (POL)
KPROF                  /PROPAR/        I*2     TROCOM.INC
                       Actual number of samples in height profile of
                       structure constant CN2.  Limited to NPROF samples.
LIN                    /LUNS/          I*2     LUNS.INC
                       TROPO.DAT input unit number.
LINKNO                 /IODATA/        I*2     IODATA.INC
                       Link number.
LISI                   /MCOM2/         I*2     MCOM.INC
                       Number of future Intersymbol Interference (ISI)
                       contributors considered in MD-918 performance
                       calculation.  Default is 2.
LNAME(20)              /IODATA/        I*2     IODATA.INC
                       Link name.  Transmitter site first, receiver site
                       second.  Used as link identifier on output files
                       FOR002.DAT and SUMPAG.OUT.
MANG                   /MCOM2/         I*2     MCOM.INC
                       Number of values of interferer azimuth/elevation pairs
                       (JANG) for which outage calculations are to be made.
                       Default is 1.
MLAST                  /PDATA/         I*2     PDATA.INC
                       Number of simulator taps.  Default is 16.
MODPAT                 /MCOM2/         I*2     MCOM.INC
                       Propagation/modem flag to select calculation mode.
                       Default is 1.
                              0 = Propagation only
                              1 = Propagation + MD-918 modem
                              2 = Propagation + AN/TRC-170 or DAR modem
                              3 = Propagation + user-defined modem
```

```
MODSIG          /MCOM2/         I*2     MCOM.INC
                Interference signal modulation format.  Default is 1.
                        0 = Analog FDM / FM
                        1 = Digital QPSK
MRAD            /ERAD/          I*2     ERAD.INC
                Loop limit for MRAD. Default is 1.
                (MRAD is 1 for MDIST = 0 and MRAD is 3 for MDIST = 1).
NACCU           /CONTRL/        I*2     TROCOM.INC
                Parameter used as truncation point for common
                volume integration termination.  Default is 40.
NANG            /RI2/           I*2     RI2.INC
                NANG is 1 if there is angle diversity (default).
NCLIME          /MCOM2/         I*2     MCOM.INC
                Flag set to 1 if ICLIME equals 2.
NERT            /MCOM2/         I*2     MCOM.INC
                Bit error rate threshold indicator for yearly fade
                outage probability calculation.  Default is 2.
                        0 = All three thresholds
                        1 = For 10**(-3) only
                        2 = For 10**(-4) only
                        3 = For 10**(-5) only
NEWCL(4)        /MCOM2/         I*2     MCOM.INC
                New climate type character string.
NFIG            /MCOM4/         R*4     MCOM.INC
                Receiver noise figure in dB.  Default is 4dB.
NOBS            /MCOM2/         I*2     MCOM.INC
                Number of diffraction obstacles. Maximum is 3,
                default is 1.
NPM(5)          /MCOM2/         I*2     MCOM.INC
                Array containing number of terrain elevation data
                points for calculation of effective antenna heights
                for each section of the diffraction path.
NPOLRX          /BUTPAR/        R*4     BUTPAR.INC
                Number of poles in the receive Butterworth filter.
NPOLTX          /BUTPAR/        I*2     BUTPAR.INC
                Number of poles in the transmit Butterworth filter.
NR              /SYSTRN/        I*2     TROCOM.INC
                Number of receive ports.
NT              /SYSTRN/        I*2     TROCOM.INC
                Number of transmit ports.
NTERR           /MCOM2/         I*2     MCOM.INC
                Control parameter for entry or calculation of
                effective antenna heights (HTE, HRE) and effective
                obstacle heights above average terrain elevation
                (HLEF).
                        0 = HTE and HRE supplied directly
                        1 = AVETX and AVERX supplied
                        2 = HI(.) supplied
PHDIV           /MCOM4/         R*4     MCOM.INC
                Squint angle between upper and lower receiver beams in
```

```
                 radians.  Default is beamwidth.
PSIRAO(NRMX)     /ANTENN/        R*4     TROCOM.INC
                 Array of receiver beam azimuths in radians.
PSIREO(NRMX)     /ANTENN/        R*4     TROCOM.INC
                 Array of receiver beam boresight elevations above
                 radio horizon in radians, ie, angle at which each
                 antenna is aimed relative to the horizon.  PSIREO(1)
                 is the main receive antenna.
PSITAO(NTMX)     /ANTENN/        R*4     TROCOM.INC
                 Array of transmitter beam azimuths in radians.
PSITEO(NTMX)     /ANTENN/        R*4     TROCOM.INC
                 Array of transmitter beam boresight elevations above
                 radio horizon in radians, ie, angle at which each
                 antenna is aimed relative to the horizon.  PSITEO(1)
                 is the main transmit antenna.
PULSE            /RZ/            I*2     RZ.INC
                 Switch controlling MD-918 pulse shape after
                 transmitter-receiver filtering.
                         PULSE = 0   Triangle
                               = 1   OQPSK matched filter
                               = 2   Sinc pulse, bandwidth equal to 1
                               = 5   RF filtering included
                 Set to 0 if IBW = 0 or KGAIN > 1.
                 Set to 5 if IBW > 0 and KGAIN = 1.
PXMIT            /MCOM4/         R*4     MCOM.INC
                 Rated transmission power in dBm.  Default is 70dBm.
RLL              /SYSTRN/        R*4     TROCOM.INC
                 Receiver line losses in dB.  Default is 0 dB.
RSEP(3)          /IODATA/        R*4     IODATA.INC
                 Separation between receive antennas.
SCPARM           /PROPAR/        R*4     TROCOM.INC
                 Wavenumber spectrum slope parameter M.  Default is
                 3.66.
SEAN             /PROPAR/        R*4     TROCOM.INC
                 Minimum monthly median of refractivity at sea level.
                 Used to calculate ERFAC if non-zero.
SP               /MCOM4/         R*4     MCOM.INC
                 Service probability.  Default is .95.
SPE              /PDATA/         R*4     PDATA.INC
                 Tap spacing in nanoseconds.  Default is 67 nsec.
SUPRES           /IODATA/        L*4     IODATA.INC
                 Supress long output in SUMPAG if true.
                 Set to TRUE if PTYPE > 9.
TAPOUT           /PDATA/         L*4     PDATA.INC
                 If true, the simulator tap values are output to the
                 output file, FOR002.DAT.  Default is TRUE.
TAPW             /MCOM4/         R*4     MCOM.INC
                 Normalized tapwidth for MD-918.  Default is .5.
                 Range is 0.25 through 1.0
TERFAC(3)        /ERAD/          R*4     ERAD.INC
```

	The three values of ERFAC when MDIST is 1.			
THER	/PATHGE/	R*4	TROCOM.INC	
	Radio horizon elevation angle at receive site in radians.			
THET	/PATHGE/	R*4	TROCOM.INC	
	Radio horizon elevation angle at transmit site in radians.			
TLL	/SYSTRN/	R*4	TROCOM.INC	
	Transmitter line losses in dB. Default is 0 dB.			
TSEP(3)	/IODATA/	R*4	IODATA.INC	
	Separation between transmit antennas in meters.			
URH(NR)	/PATHGE/	R*4	TROCOM.INC	
	Array of receive antennas horizontal offsets from great circle plane in meters.			
URL(NR)	/PATHGE/	R*4	TROCOM.INC	
	Array of receive antennas longitudinal offsets in meters.			
URV(NR)	/PATHGE/	R*4	TROCOM.INC	
	Array of receive antennas vertical offsets in meters.			
UTH(NT)	/PATHGE/	R*4	TROCOM.INC	
	Array of transmit antennas horizontal offsets in meters.			
UTL(NT)	/PATHGE/	R*4	TROCOM.INC	
	Array of transmit antennas longitudinal offsets in meters.			
UTV(NT)	/PATHGE/	R*4	TROCOM.INC	
	Array of transmit antennas vertical offsets in meters.			
WAVLEN	/SYSTRN/	R*4	TROCOM.INC	
	Wavelength in meters.			
WLT	/SYSTRN/	R*4	TROCOM.INC	
	Rated transmission power in Watts. Default is 1000 W.			
XANG(10)	/MCOM4/	R*4	MCOM.INC	
	Interferer azimuth angles in degrees. Default is 0.			
Y900	/CURVE/	R*4	CURVE.INC	
	User supplied value for 90th percentile variability curve YO(90) for DE greater than or equal 900 km. Used only when ICLIME is 2. Used to compute the equation for the YO(90) curve fit.			
YMIN	/CURVE/	R*4	CURVE.INC	
	User supplied value for 90th percentile variability curve YO(90) for DE equal to DEMIN. Used only when ICLIME is 2. Used to compute the equation for the YO(90) curve fit.			

3.4 OUTDAT

Subprogram name: Subroutine OUTDAT

Purpose: Outputs to the output file, FOR002.DAT, parameters read from the input file TROPO.DAT as well as parameters calculated from these in INDATA, UNITS and ANTGEO.

Description: Most numeric values are printed with decimal points lined up. To make formatting easier, the T format is used to place the decimal point in the 57th position. The column to tab to is 57 - the number of integer places, ie, for an I7 format tab to column 50: ...T50,I7.... Therefore the following formulas can be used to calculate x:

Integer	Iw or Iw.m	57 - w
Floating point	Fw.m	57 - (w - (m+1))
Exponential	Ew.m	57 - (w - (m+5))
Exponential	Ew.mEe	57 - (w - (m+e+3))

where x is the value to use wherever Tx will be used.

Calling sequence:

```
CALL OUTDAT (CLIMAT,ASEP,JPOW,BWT,BWR,HTO,HRO,HT,HR,PTYPE,
JBW,FJSEP,TRCTYP)
```

Contained in module: OUTDAT

Called by: INDATA

Calls: NONE

Input arguments:

CLIMAT	R*4	Climate zone indicator.
ASEP	R*4	Separation between receive antennas in meters.
JPOW	R*8	Interference signal power density in dKm/Hz.
BWT	R*4	Transmit antenna beamwidth in degrees.
BWR	R*4	Receive antenna beamwidth in degrees.
HTO	R*4	Transmit site elevation above sea level.
HRO	R*4	Receive site elevation above sea level.
HT	R*4	Transmit antenna height above ground.
HR	R*4	Receive antenna height above ground.
PTYPE	I*2	Variable which indicates whether propagation mechanism is pure troposcatter (0 or 10) or mixed troposcatter-diffraction (1 or 11).
JBW	R*8	Interfering signal bandwidth in Hz.
FJSEP	R*4	Frequency separation between signal and interferer in Hz.
TRCTYP	R*4	TRC-170 modem type indicator: 0 = 1 frequency DAR modem 1 = 2 frequency AN/TRC-170 modem

```
Output arguments:
     NONE

Global variables input from common:
     ACALC             /IODATA/        L*4     IODATA.INC
                       TRUE if the angles PSITEO and PSIREO are calculated
                       rather than read in.
     AR(NRMX)          /ANTENN/        R*4     TROCOM.INC
                       Array of receiver antenna diameters in meters.  AR(1)
                       is equivalent to RDIAM in the input file.
     AT(NTMX)          /ANTENN/        R*4     TROCOM.INC
                       Array of transmitter antenna diameters in meters.
                       AT(1) is equivalent to TDIAM in the input file.
     AVERX             /MCOM4/         R*4     MCOM.INC
                       Average terrain elevation above sea level between
                       receive site and radio horizon, in meters.
     AVETX             /MCOM4/         R*4     MCOM.INC
                       Average terrain elevation above sea level between
                       transmit site and radio horizon, in meters.
     BW                /SYSTRN/        R*4     TROCOM.INC
                       Bandwidth in Hertz.  Default is 7 MHz.
     CHGHR             /IODATA/        L*4     IODATA.INC
                       HR set to AR(1) if TRUE.
     CHGHRE            /IODATA/        L*4     IODATA.INC
                       HRE set to HR if TRUE.
     CHGHT             /IODATA/        L*4     IODATA.INC
                       HT set to AT(1) if TRUE.
     CHGHTE            /IODATA/        L*4     IODATA.INC
                       HTE set to HT if TRUE.
     CN2(NPROF)        /PROPAR/        R*4     TROCOM.INC
                       The atmospheric structure constant height profile in
                       meters to the -2/3 power.
     D                 /PATHGE/        R*4     TROCOM.INC
                       Great circle distance between transmitter and receiver
                       measured at sea level in meters.
     DEG               /UNIT/          R*4     IODATA.INC
                       String 'deg ' for units output.
     DELH              /PROPAR/        R*4     TROCOM.INC
                       Spacing of CN2 samples in meters.
     DEMIN             /CURVE/         R*4     CURVE.INC
                       User supplied minima of the 90th percentile
                       variability curve, YO(90).
     DIVTYP            /MCOM2/         I*2     MCOM.INC
                       Diversity configuration indicator.  Default is 0.
                        0 = 2 receive antennas; 2S    2S/2F    2S/2A 2S/2A/2F
                        1 = 1 receive antenna;  2A    2F       2F/2A
                        2 = 2 transmit,
                            2 receive antennas; 2S/2P 2S/2P/2A
                        3 = Not used
```

```
                 4 = User supplied parameters
                 S = Space  F = Frequency  A = Angle  P = Polarization
DL(3)            /MCOM4/         R*4     MCOM.INC
                 Array containing distance from each obstacle to
                 transmitter in meters.
DLR              /PATHGE/        R*4     TROCOM.INC
                 Distance from receiver to radio horizon in meters.
DLT              /PATHGE/        R*4     TROCOM.INC
                 Distance from transmitter to radio horizon in meters.
DRATE            /MCOM4/         R*4     MCOM.INC
                 Data rate in bits/second.  Default is 6.6E6.
DS(3)            /MCOM4/         R*4     MCOM.INC
                 Array of effective obstacle extents along the great
                 circle path in meters.
ELANG(10)        /MCOM4/         R*4     MCOM.INC
                 Interferer elevation angles in degrees.  Default is 0.
ERFAC            /PROPAR/        R*4     TROCOM.INC
                 Yearly median value of effective earth radius factor k
                 in kilometers.  Default is 1.33.
ERR              /CONTROL/       R*4     TROCOM.INC
                 Common volume integration resolution. Default is .001.
F                /SYSTRN/        R*4     TROCOM.INC
                 Operating frequency in Hz.  Model is accurate between
                 100MHz and 10GHz.
FT               /UNIT/          R*4     IODATA.INC
                 String 'ft  ' for units output.
GHZ              /UNIT/          R*4     IODATA.INC
                 String 'GHz ' for units output.
HI(155)          /MCOM4/         R*4     MCOM.INC
                 Array containing NPM(1) evenly-spaced terrain
                 elevation data (in meters) between transmitter and
                 first obstacle followed by NPM(2) evenly-spaced
                 terrain elevation data between first and second
                 obstacle, etc., ending with NPM(NOBS+1) evenly-spaced
                 terrain elevation data between last obstacle and
                 receive site. The data should be selected such that:
                         HI(1) = Terrain elevation above sea level at
                                  transmit site (HTO).
                         HI(NPM(I)) = HI (NPM(I)+1) = Elevation of Ith
                                  obstacle above sea level (HL(I)).
                         HI(NPM(NOBS+1)) = Terrain elevation above sea
                                  level at receive site (HRO).
                 In MDTS, HI is used as work space.  It is equivalenced
                 to local arrays.
HL(3)            /MCOM4/         R*4     MCOM.INC
                 Array containing elevation of each obstacle above sea
                 level in meters.  HL(1) is elevation of transmitter
                 radio horizon HLT.  HL(NOBS) is elevation of receiver
                 radio horizon HLR.
HLAV(3)          /MCOM4/         R*4     MCOM.INC
```

CHAPTER 4

ERROR UTILITIES

This section describes the data checking and error handling routines:

Name	Description	User's Manual section
CHKDAT	Check data	2.2
ERROR	Error message output	2.3, 3.4.3
SUBID	Subprogram output identifier .	NA

CHKDAT is only a preliminary data checking routine. More testing is done throughout TROPO, ERROR being called when a warning is to be printed or when a fatal error has been found. ERROR writes oth to the user's terminal and the error output file FOR002.DAT, units LTERM and LERR. FOR002.DAT is described in section 3.4.3 of the User's Manual.

NOTE

In most cases the sections in the User's Manual describe the coded equations as well as the theory behind them. NA denotes routines that are programming utilities such as finding indices, setting pointers, etc.

3.7 UNITS

Subprogram name: Subroutine UNITS

Purpose: Determine combination of measurement units requested by the user. UNITS sets LUNITS to a unique number for the combination of distance (statute miles, nautical miles, kilometers), height/diameter (feet, meters), angle (degrees, milliradians), and frequency (Gigahertz, Megahertz). LUNITS is used in subroutines OUTDAT and SUMPAG to output data in the user's units and in UNITCV to convert back and forth to MKS units.

Calling sequence:
CALL UNITS

Contained in module: UNITS

Called by: INDATA

Calls: ERRIO

Input arguments:
NONE

Output arguments:
NONE

Global variables input from common:

DEG	/UNIT/	R*4	IODATA.INC
	String 'deg ' for units output.		
FT	/UNIT/	R*4	IODATA.INC
	String 'ft ' for units output.		
GHZ	/UNIT/	R*4	IODATA.INC
	String 'GHz ' for units output.		
KM	/UNIT/	R*4	IODATA.INC
	String 'km ' for units output.		
LERR	/LUNS/	I*2	LUNS.INC
	Error output unit.		
MET	/UNIT/	R*4	IODATA.INC
	String 'met ' for units output.		
MHZ	/UNIT/	R*4	IODATA.INC
	String 'MHz ' for units output.		
MRADNS	/UNIT/	R*4	IODATA.INC
	String 'mrad' for units output.		
NMI	/UNIT/	R*4	IODATA.INC
	String 'nmi ' for units output.		
SMI	/UNIT/	R*4	IODATA.INC
	String 'smi ' for units output.		

Global variables output to common:

	antenna is aimed relative to the horizon. PSIREO(1) is the main receive antenna.		
PSITAO(NTMX)	/ANTENN/	R*4	TROCOM.INC
	Array of transmitter beam azimuths in radians.		
PSITEO(NTMX)	/ANTENN/	R*4	TROCOM.INC
	Array of transmitter beam boresight elevations above radio horizon in radians, ie, angle at which each antenna is aimed relative to the horizon. PSITEO(1) is the main transmit antenna.		
THER	/PATHGE/	R*4	TROCOM.INC
	Radio horizon elevation angle at receive site in radians.		
THET	/PATHGE/	R*4	TROCOM.INC
	Radio horizon elevation angle at transmit site in radians.		
THETAO	/PATHGE/	R*4	TROCOM.INC
	Scattering angle at bottom of common volume in radians.		
URH(NR)	/PATHGE/	R*4	TROCOM.INC
	Array of receive antennas horizontal offsets from great circle plane in meters.		
URL(NR)	/PATHGE/	R*4	TROCOM.INC
	Array of receive antennas longitudinal offsets in meters.		
URV(NR)	/PATHGE/	R*4	TROCOM.INC
	Array of receive antennas vertical offsets in meters.		
UTH(NT)	/PATHGE/	R*4	TROCOM.INC
	Array of transmit antennas horizontal offsets in meters.		
UTL(NT)	/PATHGE/	R*4	TROCOM.INC
	Array of transmit antennas longitudinal offsets in meters.		
UTV(NT)	/PATHGE/	R*4	TROCOM.INC
	Array of transmit antennas vertical offsets in meters.		
Y1	/PATHGE/	R*4	TROCOM.INC
	Maximum estimated integration length in Y-direction.		

HI(NPM(NOBS+1)) = Terrain elevation above sea level at receive site (HRO).
In MDTS, HI is used as work space. It is equivalenced to local arrays.

HL(3)	/MCOM4/	R*4	MCOM.INC
	Array containing elevation of each obstacle above sea level in meters. HL(1) is elevation of transmitter radio horizon HLT. HL(NOBS) is elevation of receiver radio horizon HLR.		
HLAV(3)	/MCOM4/	R*4	MCOM.INC
	Array containing average terrain elevation at each diffraction point in meters.		
HLEF(3)	/MCOM4/	R*4	MCOM.INC
	Array containing effective height of obstacles above average terrain elevation in meters.		
HLOW	/PROPAR/	R*4	TROCOM.INC
	Lowest height above sea level at which CN2 is specified in meters.		
HLR	/PATHGE/	R*4	TROCOM.INC
	Receiver radio horizon elevation above sea level in meters.		
HLT	/PATHGE/	R*4	TROCOM.INC
	Transmit radio horizon elevation above sea level in meters.		
HRE	/MCOM4/	R*4	MCOM.INC
	Effective receiver antenna height above average terrain elevation in meters.		
HRN	/PATHGE/	R*4	TROCOM.INC
	Receive antenna height above sea level in meters.		
HTE	/MCOM4/	R*4	MCOM.INC
	Effective transmitter antenna height above average terrain elevation in meters.		
HTN	/PATHGE/	R*4	TROCOM.INC
	Transmit antenna height above sea level in meters.		
PHDIV	/MCOM4/	R*4	MCOM.INC
	Squint angle between upper and lower receiver beams in radians. Default is beamwidth.		
PHI	/PATHGE/	R*4	TROCOM.INC
	Diffraction angle in radians.		
PHIR	/PATHGE/	R*4	TROCOM.INC
	Receive angular distance to minimum scattering point in radians.		
PHIT	/PATHGE/	R*4	TROCOM.INC
	Transmit angular distance to minimum scattering point in radians.		
PSIRAO(NRMX)	/ANTENN/	R*4	TROCOM.INC
	Array of receiver beam azimuths in radians.		
PSIREO(NRMX)	/ANTENN/	R*4	TROCOM.INC
	Array of receiver beam boresight elevations above radio horizon in radians, ie, angle at which each		

BETA0	/PATHGE/	R*4	TROCOM.INC
	Minimum receive antenna elevation angle measured from receiver-to-transmitter line to receiver horizon line in radians.		
BETA1	/PATHGE/	R*4	TROCOM.INC
	Maximum receive antenna elevation angle measured from receiver-to-transmitter line to top of common volume in radians.		
D	/PATHGE/	R*4	TROCOM.INC
	Great circle distance between transmitter and receiver measured at sea level in meters.		
DELH	/PROPAR/	R*4	TROCOM.INC
	Spacing of CN2 samples in meters.		
DL(3)	/MCOM4/	R*4	MCOM.INC
	Array containing distance from each obstacle to transmitter in meters.		
DLR	/PATHGE/	R*4	TROCOM.INC
	Distance from receiver to radio horizon in meters.		
DLT	/PATHGE/	R*4	TROCOM.INC
	Distance from transmitter to radio horizon in meters.		
DR	/PATHGE/	R*4	TROCOM.INC
	Receiver distance to minimum scattering point in meters.		
DS(3)	/MCOM4/	R*4	MCOM.INC
	Array of effective obstacle extents along the great circle path in meters.		
DT	/PATHGE/	R*4	TROCOM.INC
	Transmit antenna distance to minimum scattering point in meters.		
F	/SYSTRN/	R*4	TROCOM.INC
	Operating frequency in Hz. Model is accurate between 100MHz and 10GHz.		
HCOM	/PATHGE/	R*4	TROCOM.INC
	Effective height of the bottom of the common volume in meters.		
HHIGH	/PATHGE/	R*4	TROCOM.INC
	Effective height of the top of the common volume in meters.		
HI(155)	/MCOM4/	R*4	MCOM.INC
	Array containing NPM(1) evenly-spaced terrain elevation data (in meters) between transmitter and first obstacle followed by NPM(2) evenly-spaced terrain elevation data between first and second obstacle, etc., ending with NPM(NOBS+1) evenly-spaced terrain elevation data between last obstacle and receive site. The data should be selected such that: HI(1) = Terrain elevation above sea level at transmit site (HTO). HI(NPM(I)) = HI (NPM(I)+1) = Elevation of Ith obstacle above sea level (HL(I)).		

Integer value that specifies the set of units requested by the user. These units are for path, antenna location, angle, and frequency parameters. Default is 8. The given units are defined by bit values of LUNITS:

Bit no.	Meaning of value 0 / 1
0	english / metric
1	statute miles / nautical miles
2	feet / meters
3	mrad / degrees
4	GHz / MHz

Valid LUNITS values are

0 :	stat. miles	- feet	- milliradians	- GHz
1 :	kilometers	- meters	- milliradians	- GHz
2 :	naut. miles	- feet	- milliradians	- GHz
8 :	stat. miles	- feet	- degrees	- GHz
9 :	kilometers	- meters	- degrees	- GHz
10:	naut.miles	- feet	- degrees	- GHZ
16:	stat. miles	- feet	- milliradians	- MHz
17:	kilometers	- meters	- milliradians	- MHz
18:	naut. miles	- feet	- milliradians	- MHz
24:	stat. miles	- feet	- degrees	- MHz
25:	kilometers	- meters	- degrees	- MHz
26:	naut. miles	- feet	- degrees	- MHz

NR /SYSTRN/ I*2 TROCOM.INC
Number of receive ports.

NT /SYSTRN/ I*2 TROCOM.INC
Number of transmit ports.

Global variables output to common:

ALFA0 /PATHGE/ R*4 TROCOM.INC
Minimum transmit antenna elevation angle measured from transmitter-to-receiver line to transmit horizon line in radians.

ALFA1 /PATHGE/ R*4 TROCOM.INC
Maximum transmit antenna elevation angle measured from transmitter-to-receiver line to top of common volume in radians.

AR(NRMX) /ANTENN/ R*4 TROCOM.INC
Array of receiver antenna diameters in meters. AR(1) is equivalent to RDIAM in the input file.

AT(NTMX) /ANTENN/ R*4 TROCOM.INC
Array of transmitter antenna diameters in meters. AT(1) is equivalent to TDIAM in the input file.

AVERX /MCOM4/ R*4 MCOM.INC
Average terrain elevation above sea level between receive site and radio horizon, in meters.

AVETX /MCOM4/ R*4 MCOM.INC
Average terrain elevation above sea level between transmit site and radio horizon, in meters.

3.6 UNITCV

Subprogram name: Subroutine UNITCV

Purpose: UNITCV converts data to MKS units if the argument is positive and converts from MKS units to input units (those requested by the user in the input file, TROPO.DAT) if the argument is negative. This allows the user freedom to input in desired units and see the output in the same units but still allow the program to run with the units it expects. MKS units are: meters for height, distance and elvation, seconds for time, radians for angles, and Hz for the operating frequency. Bandwidths and data rates are not converted.

Calling sequence:
CALL UNITCV (IDIR)

Contained in module: UNITCV

Called by: INDATA, SUMPAG

Calls: ERROR

Input arguments:

```
IDIR    I*2     Directive flag:
                  >0  Convert to MKS units.
                  <0  Convert to user's units.
```

Output arguments:
NONE

Global variables input from common:

```
CDEGR          /CONSTA/        R*4     CONSTANTS.INC
               Radians per degree = 0.017453293.
CE3            /CONSTA/        R*4     CONSTANTS.INC
               1 X 10**3 = 1000.
CMTPFT         /CONSTA/        R*4     CONSTANTS.INC
               Meters per foot = 0.3048.
CMTPMI         /CONSTA/        R*4     CONSTANTS.INC
               Meters per statute mile = 1609.344
CMTPNM         /CONSTA/        R*4     CONSTANTS.INC
               Meters per nautical mile = 1852.
IDM            /UNIT/          I*2     IODATA.INC
               0 if degrees, 1 if milliradians.
IME            /UNIT/          I*2     IODATA.INC
               0 if metric units, 1 if English.
IMG            /UNIT/          I*2     IODATA.INC
               0 if MHz, 1 if GHz.
INS            /UNIT/          I*2     IODATA.INC
               0 if nautical miles, 1 if statute miles.
LUNITS         /UNIT/          I*2     IODATA.INC
```

3.5 SECTOR

Subprogram name: Subroutine SECTOR

Purpose: Search for a section header.

Description: SECTOR searches for a section header in the input file TROPO.DAT by reading lines until the first four characters on the line match the string passed in Y.

Calling sequence:
```
CALL SECTOR (Y, X)
```

Contained in module: INDATA

Called by: INDATA

Calls: ERRIO

Input arguments:

Y	R*4	Word to search for.

Output arguments:

X	R*4	Word found.

Global variables input from common:

LERR	/LUNS/	I*2	LUNS.INC
	Error output unit.		

Global variables output to common:

LIN	/LUNS/	I*2	LUNS.INC
	TROPO.DAT input unit number.		

2 = Calculate reference horizon using HORANG and K equals ERFAC. (Assuming DLT and DLR are non-zero.)

3 = Do not change reference horizons from previous run. (Option not available.)

	characters.			
UANGLE	/UNIT/	R*4	IODATA.INC	
	Units of angle (deg, mrad).			
UDIST	/UNIT/	R*4	IODATA.INC	
	Units of distance (smi, nmi, km).			
UFREQ	/UNIT/	R*4	IODATA.INC	
	Units of frequency (GHz, MHz).			
UHITE	/UNIT/	R*4	IODATA.INC	
	Units of height and diameter (ft, m).			
URH(NR)	/PATHGE/	R*4	TROCOM.INC	
	Array of receive antennas horizontal offsets from great circle plane in meters.			
URL(NR)	/PATHGE/	R*4	TROCOM.INC	
	Array of receive antennas longitudinal offsets in meters.			
URV(NR)	/PATHGE/	R*4	TROCOM.INC	
	Array of receive antennas vertical offsets in meters.			
UTH(NT)	/PATHGE/	R*4	TROCOM.INC	
	Array of transmit antennas horizontal offsets in meters.			
UTL(NT)	/PATHGE/	R*4	TROCOM.INC	
	Array of transmit antennas longitudinal offsets in meters.			
UTV(NT)	/PATHGE/	R*4	TROCOM.INC	
	Array of transmit antennas vertical offsets in meters.			
WLT	/SYSTRN/	R*4	TROCOM.INC	
	Rated transmission power in Watts. Default is 1000 W.			
XANG(10)	/MCOM4/	R*4	MCOM.INC	
	Interferer azimuth angles in degrees. Default is 0.			
Y900	/CURVE/	R*4	CURVE.INC	
	User supplied value for 90th percentile variability curve Y0(90) for DE greater than or equal 900 km. Used only when ICLIME is 2. Used to compute the equation for the Y0(90) curve fit.			
YMIN	/CURVE/	R*4	CURVE.INC	
	User supplied value for 90th percentile variability curve Y0(90) for DE equal to DEMIN. Used only when ICLIME is 2. Used to compute the equation for the Y0(90) curve fit.			

Global variables output to common:

ITOFF	/PROPAR/	I*2	TROCOM.INC	
	Control indicator for entry or calculation of transmit/receive radio horizon angles THET and THER. Values have following meanings:			

0 = Use input THET, THER as reference and actual horizon (default).

1 = Calculate reference horizon using HORANG and K equals 1.33. (Assuming DLT and DLR are non-zero.) (Option not available.)

	effective antenna heights (HTE, HRE) and effective obstacle heights above average terrain elevation (HLEF). 0 = HTE and HRE supplied directly 1 = AVETX and AVERX supplied 2 = HI(.) supplied		
PHDIV	/MCOM4/	R*4	MCOM.INC
	Squint angle between upper and lower receiver beams in radians. Default is beamwidth.		
PSIRAO(NRMX)	/ANTENN/	R*4	TROCOM.INC
	Array of receiver beam azimuths in radians.		
PSIREO(NRMX)	/ANTENN/	R*4	TROCOM.INC
	Array of receiver beam boresight elevations above radio horizon in radians, ie, angle at which each antenna is aimed relative to the horizon. PSIREO(1) is the main receive antenna.		
PSITAO(NTMX)	/ANTENN/	R*4	TROCOM.INC
	Array of transmitter beam azimuths in radians.		
PSITEO(NTMX)	/ANTENN/	R*4	TROCOM.INC
	Array of transmitter beam boresight elevations above radio horizon in radians, ie, angle at which each antenna is aimed relative to the horizon. PSITEO(1) is the main transmit antenna.		
PXMIT	/MCOM4/	R*4	MCOM.INC
	Rated transmission power in dBm. Default is 70dBm.		
RLL	/SYSTRN/	R*4	TROCOM.INC
	Receiver line losses in dB. Default is 0 dB.		
SCPARM	/PROPAR/	R*4	TROCOM.INC
	Wavenumber spectrum slope parameter M. Default is 3.66.		
SEAN	/PROPAR/	R*4	TROCOM.INC
	Minimum monthly median of refractivity at sea level. Used to calculate ERFAC if non-zero.		
SMI	/UNIT/	R*4	IODATA.INC
	String 'smi ' for units output.		
SP	/MCOM4/	R*4	MCOM.INC
	Service probability. Default is .95.		
TAPW	/MCOM4/	R*4	MCOM.INC
	Normalized tapwidth for MD-918. Default is .5. Range is 0.25 through 1.0		
THER	/PATHGE/	R*4	TROCOM.INC
	Radio horizon elevation angle at receive site in radians.		
THET	/PATHGE/	R*4	TROCOM.INC
	Radio horizon elevation angle at transmit site in radians.		
TLL	/SYSTRN/	R*4	TROCOM.INC
	Transmitter line losses in dB. Default is 0 dB.		
TODAY(9)	/TSTAMP/	L*1	IODATA.INC
	Array used in PDP-11 version to hold date as		

MODPAT	/MCOM2/	I*2	MCOM.INC	
	Propagation/modem flag to select calculation mode. Default is 1. 0 = Propagation only 1 = Propagation + MD-918 modem 2 = Propagation + AN/TRC-170 or DAR modem 3 = Propagation + user-defined modem			
MODSIG	/MCOM2/	I*2	MCOM.INC	
	Interference signal modulation format. Default is 1. 0 = Analog FDM / FM 1 = Digital QPSK			
MRADNS	/UNIT/	R*4	IODATA.INC	
	String 'mrad' for units output.			
NACCU	/CONTRL/	I*2	TROCOM.INC	
	Parameter used as truncation point for common volume integration termination. Default is 40.			
NCLIME	/MCOM2/	I*2	MCOM.INC	
	Flag set to 1 if ICLIME equals 2.			
NERT	/MCOM2/	I*2	MCOM.INC	
	Bit error rate threshold indicator for yearly fade outage probability calculation. Default is 2. 0 = All three thresholds 1 = For 10**(-3) only 2 = For 10**(-4) only 3 = For 10**(-5) only			
NEWCL(4)	/MCOM2/	I*2	MCOM.INC	
	New climate type character string.			
NFIG	/MCOM4/	R*4	MCOM.INC	
	Receiver noise figure in dB. Default is 4dB.			
NMI	/UNIT/	R*4	IODATA.INC	
	String 'nmi ' for units output.			
NOBS	/MCOM2/	I*2	MCOM.INC	
	Number of diffraction obstacles. Maximum is 3, default is 1.			
NOW(8)	/TSTAMP/	L*1	IODATA.INC	
	Array used in PDP-11/70 version to hold time of day as characters.			
NPM(5)	/MCOM2/	I*2	MCOM.INC	
	Array containing number of terrain elevation data points for calculation of effective antenna heights for each section of the diffraction path.			
NR	/SYSTRN/	I*2	TROCOM.[illegible]	
	Number of receive ports.			
NT	/SYSTRN/	I*2	TROCOM.INC	
	Number of transmit ports.			
NTAP	/MCOM2/	I*2	MCOM.INC	
	Number of adaptive forward equalizer taps (AFE) in MD-918 modem. Set to 3 in INDATA.			
NTERR	/MCOM2/	I*2	MCOM.INC	
	Control parameter for entry or calculation of			

	1 = Interferer covariance matrix calculation done in subroutine JAMCOM			
KM	/UNIT/	R*4	IODATA.INC	
	String 'km ' for units output.			
KPROF	/PROPAR/	I*2	TROCOM.INC	
	Actual number of samples in height profile of structure constant CN2. Limited to NPROF samples.			
LISI	/MCOM2/	I*2	MCOM.INC	
	Number of future Intersymbol Interference (ISI) contributors considered in MD-918 performance calculation. Default is 2.			
LNAME(20)	/IODATA/	I*2	IODATA.INC	
	Link name. Transmitter site first, receiver site second. Used as link identifier on output files FOR002.DAT and SUMPAG.OUT.			
LOUT	/LUNS/	I*2	LUNS.INC	
	FOR002.DAT output unit number.			
LUNITS	/UNIT/	I*2	IODATA.INC	
	Integer value that specifies the set of units requested by the user. These units are for path, antenna location, angle, and frequency parameters. Default is 8. The given units are defined by bit values of LUNITS:			

Bit no.	Meaning of value 0 / 1
0	english / metric
1	statute miles / nautical miles
2	feet / meters
3	mrad / degrees
4	GHz / MHz

Valid LUNITS values are

0 :	stat. miles	- feet	- milliradians	- GHz
1 :	kilometers	- meters	- milliradians	- GHz
2 :	naut. miles	- feet	- milliradians	- GHz
8 :	stat. miles	- feet	- degrees	- GHz
9 :	kilometers	- meters	- degrees	- GHz
10:	naut.miles	- feet	- degrees	- GHZ
16:	stat. miles	- feet	- milliradians	- MHz
17:	kilometers	- meters	- milliradians	- MHz
18:	naut. miles	- feet	- milliradians	- MHz
24:	stat. miles	- feet	- degrees	- MHz
25:	kilometers	- meters	- degrees	- MHz
26:	naut. miles	- feet	- degrees	- MHz

MANG	/MCOM2/	I*2	MCOM.INC
	Number of values of interferer azimuth/elevation pairs (JANG) for which outage calculations are to be made. Default is 1.		
MET	/UNIT/	R*4	IODATA.INC
	String 'met ' for units output.		
MHZ	/UNIT/	R*4	IODATA.INC
	String 'MHz ' for units output.		

	Array containing average terrain elevation at each diffraction point in meters.		
HLEF(3)	/MCOM4/	R*4	MCOM.INC
	Array containing effective height of obstacles above average terrain elevation in meters.		
HLOW	/PROPAR/	R*4	TROCOM.INC
	Lowest height above sea level at which CN2 is specified in meters.		
HLR	/PATHGE/	R*4	TROCOM.INC
	Receiver radio horizon elevation above sea level in meters.		
HLT	/PATHGE/	R*4	TROCOM.INC
	Transmit radio horizon elevation above sea level in meters.		
HRN	/PATHGE/	R*4	TROCOM.INC
	Receive antenna height above sea level in meters.		
HTE	/MCOM4/	R*4	MCOM.INC
	Effective transmitter antenna height above average terrain elevation in meters.		
HTN	/PATHGE/	R*4	TROCOM.INC
	Transmit antenna height above sea level in meters.		
IBR(NRMX,NRMX)	/SYSTRN/	I*2	TROCOM.INC
	Channel complex-envelope correlation and cross-correlation calculation indicator array. 0 = No calculation 1 = Power (correlation) calculation only 2 = Power (correlation) per unit delay spectrum calculation		
IBW	/MCOM2/	I*2	MCOM.INC
	Switch indicating type of RF bandwidth constraint to be used on desired signal. Default is 0. 0 = No RF filtering 1 = Filter determined from 99% bandwidth constraint 2 = Filter chosen to meet FCC Mask. (FCC-19311) 3 = Filters are user specified		
ICLIME	/MCOM2/	I*2	MCOM.INC
	Climate class. Default is 0. 0 = NBS TN-101 climate 1 = MIL-HDBK-417 climate 2 = New, user-supplied climate		
IPOLR(NRMX)	/ANTENN/	I*2	TROCOM.INC
	Array of receiver antenna polarizations.		
IPOLT(NTMX)	/ANTENN/	I*2	TROCOM.INC
	Array of transmitter antenna polarizations.		
JFILT	/MCOM2/	I*2	MCOM.INC
	Interference covariance matrix calculation indicator. Only used when IBW equals 0, otherwise ignored. Default is 0. 0 = Interferer covariance matrix calculation done in subroutine BOTAC		

4.1 CHKDAT

Subprogram name: Subroutine CHKDAT

Purpose: Performs a preliminary check of the validity of the data read from the input file TROPO.DAT. Array bounds, path symmetry, and validity of the specified correlations (through the array IBR) are verified. Further checking is done throughout TROPO.

Calling sequence:
CALL CHKDAT

Contained in module: CHKDAT

Called by: TROPO

Calls: ERROR

Input arguments:
NONE

Output arguments:
NONE

Global variables input from common:

```
AR(NRMX)        /ANTENN/       R*4    TROCOM.INC
                Array of receiver antenna diameters in meters.  AR(1)
                is equivalent to RDIAM in the input file.
AT(NTMX)        /ANTENN/       R*4    TROCOM.INC
                Array of transmitter antenna diameters in meters.
                AT(1) is equivalent to TDIAM in the input file.
IBR(NRMX,NRMX)  /SYSTRN/       I*2    TROCOM.INC
                Channel complex-envelope correlation and
                cross-correlation calculation indicator array.
                        0 = No calculation
                        1 = Power (correlation) calculation only
                        2 = Power (correlation) per unit delay
                            spectrum calculation
NR              /SYSTRN/       I*2    TROCOM.INC
                Number of receive ports.
NRMX            Parameter      I*2    TROPAR.INC
                Maximum number of receive ports.
NT              /SYSTRN/       I*2    TROCOM.INC
                Number of transmit ports.
NTMX            Parameter      I*2    TROPAR.INC
                Maximum number of transmit ports.
PSIRAO(NRMX)    /ANTENN/       R*4    TROCOM.INC
                Array of receiver beam azimuths in radians.
PSIREO(NRMX)    /ANTENN/       R*4    TROCOM.INC
                Array of receiver beam boresight elevations above
```

	radio horizon in radians, ie, angle at which each antenna is aimed relative to the horizon. PSIREO(1) is the main receive antenna.			
PSITAO(NTMX)	/ANTENN/	R*4	TROCOM.INC	
	Array of transmitter beam azimuths in radians.			
PSITEO(NTMX)	/ANTENN/	R*4	TROCOM.INC	
	Array of transmitter beam boresight elevations above radio horizon in radians, ie, angle at which each antenna is aimed relative to the horizon. PSITEO(1) is the main transmit antenna.			
URH(NR)	/PATHGE/	R*4	TROCOM.INC	
	Array of receive antennas horizontal offsets from great circle plane in meters.			
URL(NR)	/PATHGE/	R*4	TROCOM.INC	
	Array of receive antennas longitudinal offsets in meters.			
URV(NR)	/PATHGE/	R*4	TROCOM.INC	
	Array of receive antennas vertical offsets in meters.			
UTH(NT)	/PATHGE/	R*4	TROCOM.INC	
	Array of transmit antennas horizontal offsets in meters.			
UTL(NT)	/PATHGE/	R*4	TROCOM.INC	
	Array of transmit antennas longitudinal offsets in meters.			
UTV(NT)	/PATHGE/	R*4	TROCOM.INC	
	Array of transmit antennas vertical offsets in meters.			

4.2 ERROR

Subprogram name: Subroutine ERROR

Purpose: Outputs error number and error message to terminal (unit LTERM) and the output file FOR002.DAT (unit LOUT).

Description: Checking for input errors is done throughout TROPO. When a fatal error or data inconsistency is found, processing transfers to subroutine ERROR. Most errors found are fatal so processing branches to line 500 to STOP after outputting the message; others are merely warnings and branch to 600 to return to the calling program and continue processing.

The errors are divided in the source code by calling routine so a check of the code or FORMAT statements reveals in which routine the error was encountered.

Note that for all error 999s the calling program has already printed an error message to the output file FOR002.DAT before calling ERROR.

Calling sequence:
CALL ERROR (I)

Contained in module: ERROR

Called by: ANTPAR ATMOS CHANGE CHKDAT CLIME CLIMIL CLIMIX DEIND LOOPS MATA MDIF MDTS ORDER RIPROF SIGIN SQTMAT SUMPAG TRANSF TRCIN TRLOSS UNITCV UNITS

Calls: NONE

Input arguments:

I	I*2	Error number.

Output arguments:
NONE

Global variables input from common:

LOUT	/LUNS/	I*2	LUNS.INC
	FOR002.DAT output unit number.		

4.3 SUBID

Subprogram name: Subroutine SUBID

Purpose: Subroutine to identify blocks of output or output variables by writing 'SNAME', the subprogram printing such output, to logical unit, LOUT.

Calling sequence:
CALL SUBID (SNAME)

Contained in module: SUBID

Called by:

Calls: NONE

Input arguments:
SNAME R*8 Name of subprogram to output.

Output arguments:
NONE

Global variables input from common:
LOUT /LUNS/ I*2 LUNS.INC
FOR002.DAT output unit number.

CHAPTER 5

TROPOSCATTER CALCULATIONS

This section describes the tropospheric scatter calculation routines:

Name	Description	User's Manual section
ANTPAR	Antenna parameters	2.5.2.1
ANTPTR	Antenna pointers	NA
ATMOS	Atmospheric absorption calculations	2.5.2.4
AVTER	Average terrain height	2.5.4.7
BEAMPT	Beam pointers	NA
DELO	Delay	NA
ERFC	Complimentary error function .	NA
FRQSEP	Frequency separation	2.5.6.3
GPATT	Voltage gain pattern	2.5.2.1
HORANG	Horizon elevation angles . . .	NA
INTLIM	Integration limits	2.5.2.2
LOOPS	Main routine for common volume integration	2.5.6.1
LTCORR	Long term variability correction factor	2.5.7
POWER	Long term RSL and SNR distribution	2.5, 2.5.4.6
RGAIN	Receive antenna voltage gain pattern	2.5.2
RIPROF	Structure constant profile calculation	2.5.2.3
STEPAB	Step size of alpha and beta . .	NA
STEPY	Step size of Y	NA
STPPAR	Step size parameters	NA
TGAIN	Transmit antenna voltage gain pattern	2.5.2
TRANSF	Transform angles and distances	2.5.2, 2.5.2.2
TRLOSS	Theoretical calculation of basic pathloss	NA

The main routines for this section are LOOPS and POWER. The troposcatter calculations are described in section 2.5 of the User's Manual.

Figure 2-2 is a top level flowchart for troposcatter propagation parameter calculations at a functional level. In most cases the blocks correspond to one or more subprograms. The test blocks (diamonds) correspond to logical branches which are decided by the user's choices of input data.

NOTE

In most cases the sections in the User's Manual describe the coded equations as well as the theory behind them. NA denotes routines that are programming utilities such as finding indices, setting pointers, etc.

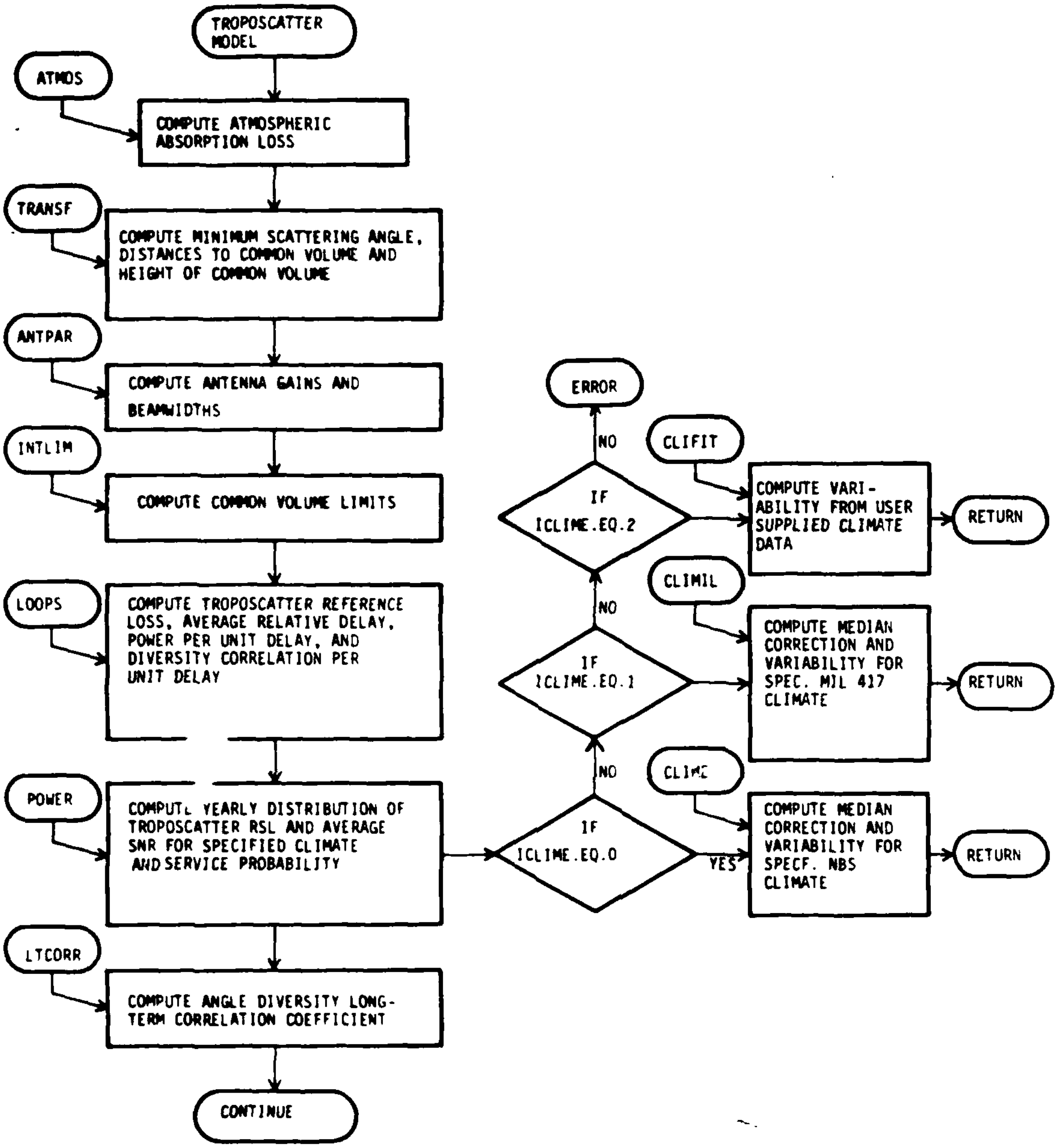


Figure 2-2 Flow Chart for Troposcatter Propagation Parameter Calculations

5.1 ANTPAR

Subprogram name: Subroutine ANTPAR

Purpose: For NPORT>0 ANTPAR returns the gain in dB of transmit antenna number NPORT and the 3dB half-beamwidth in radians. For NPORT<0 the values are for receive beam number -NPORT.

Calling sequence:
CALL ANTPAR (NPORT,GDB,DEL)

Contained in module: ANTPAR

Called by: TROPO

Calls: ERROR

Input arguments:

NPORT	I*2	Antenna number.

Output arguments:

GDB	R*4	Gain of requested antenna in dB.
DEL	R*4	3dB half-beamwidth in radians.

Global variables input from common:

AR(NRMX)	/ANTENN/	R*4	TROCOM.INC
	Array of receiver antenna diameters in meters. AR(1) is equivalent to RDIAM in the input file.		
AT(NTMX)	/ANTENN/	R*4	TROCOM.INC
	Array of transmitter antenna diameters in meters. AT(1) is equivalent to TDIAM in the input file.		
NRMX	Parameter	I*2	TROPAR.INC
	Maximum number of receive ports.		
NTMX	Parameter	I*2	TROPAR.INC
	Maximum number of transmit ports.		
WAVLEN	/SYSTRN/	R*4	TROCOM.INC
	Wavelength in meters.		

5.2 ANTPTR

Subprogram name: Subroutine ANTPTR

Purpose: Set up pointers to distinct antenna locations to avoid duplication of operations in the critical parts of LOOPS.

Calling sequence:

```
CALL ANTPTR (NPORTS, UH, UV, UL, NANT, LOC)
```

Contained in module: ANTPTR

Called by: LOOPS, SUMPAG

Calls: NONE

Input arguments:

NPORTS	I*2	Number of transmit or receive ports.
UH(NPORTS)	R*4	Horizontal offsets of antennas.
UV(NPORTS)	R*4	Vertical offsets of antennas.
UL(NPORTS)	R*4	Longitudinal offsets of antennas.

Output arguments:

NANT	I*2	Number of distinct antenna locations.
LOC(NPORTS)	I*2	Pointers to location of antenna.

5.3 ATMOS

Subprogram name: Subroutine ATMOS

Purpose: Calculate atmospheric attenuation AA in dB for a troposcatter/diffraction path of length D in meters at frequency F in Hz. D must be less than 500 km and F must be less than 35 GHz.

Calling sequence:
CALL ATMOS

Contained in module: ATMOS

Called by: TROPO

Calls: ERROR

Input arguments:
NONE

Output arguments:
NONE

Global variables input from common:

D	/PATHGE/	R*4	TROCOM.INC
	Great circle distance between transmitter and receiver measured at sea level in meters.		
F	/SYSTRN/	R*4	TROCOM.INC
	Operating frequency in Hz. Model is accurate between 100MHz and 10GHz.		

Global variables output to common:

AA	/PROPAR/	R*4	TROCOM.INC
	Atmospheric absorption loss in dB.		

5.4 AVTER

Subprogram name: Subroutine AVTER

Purpose: Routine to calculate average terrain height above sea level at TWO terminal points 1 and 2 given NP evenly spaced terrain elevation data points between them by fitting a straight line to terrain data.

Calling sequence:

```
CALL AVTER (H1AV,H2AV,HI,NP,X0,X20,D)
```

Contained in module: AVTER

Called by: DIFSNR, POWER

Calls: NONE

Input arguments:

HI(NP)	R*4	Array of NP evenly spaced terrain elevations in meters above sea level.
NP	I*2	Number of data points used to calculate average heights.
X0	R*4	Distance of first terrain height data point from terminal point 1 in meters.
X20	R*4	Distance of last terrain height point from terminal 1 in meters.
D	R*4	Distance between terminal points 1 and 2 in meters.

Output arguments:

H1AV	R*4	Average terrain height at terminal 1 in meters.
H2AV	R*4	Average terrain height at terminal 2 in meters.

5.5 BEAMPT

Subprogram name: Subroutine BEAMPT

Purpose: Set up pointers to distinct receive antenna beams to avoid duplication of operations in the critical parts of LOOPS. The pointers are used in LOOPS to calculate angle diversity correlations for a troposcatter receiver.

Calling sequence:

```
CALL BEAMPT (NPORTS, PSIE, PSIA, NBEAM, IBEAM, JBEAM)
```

Contained in module: BEAMPT

Called by: LOOPS

Calls: NONE

Input arguments:

NPORTS	I*2	Number of transmit or receive ports.
PSIE(NPORTS)	R*4	Beam boresight elevations above radio horizon.
PSIA(NPORTS)	R*4	Beam azimuths.

Output arguments:

NBEAM	I*2	Number of distinct beams.
IBEAM(NPORTS)	I*2	Pointers to antenna ports from beam number. IBEAM(I) identifies the lowest numbered port with antenna pattern number I.
JBEAM(NPORTS)	I*2	Pointers to beam number from antenna port. JBEAM(I) is the antenna pattern of antenna port number I.

5.6 DELO

Subprogram name: Subroutine DELO

Purpose: *Calculates the delay, relative to DC, from the transmitter to a scattering point to the receiver. The scattering point is characterized by ALFA, BETA, and DC. This delay value is used in the LOOPS integration for the calculation of the delay profile.*

Calling sequence:
CALL DELO (ALFA, BETA, DC, DEL)

Contained in module: DELO

Called by: LOOPS

Calls: NONE

Input arguments:

ALFA	R*4	Angle between the transmitter-receiver line and the transmitter-scatterer line in radians.
BETA	R*4	Angle between the receiver-transmitter line and the receiver-scatterer line in radians.
DC	R*4	Delay between transmitter and receiver (straight line, free space) in seconds.

Output arguments:

DEL	R*4	Transmitter-scatter-receiver delay less the miminum delay DC in seconds.

5.7 ERFC

Subprogram name: Function ERFC

Purpose: Complimentary error function approximation.

Reference: Abramowitz and Stegun, Handbook of Mathematical Functions, 1968, p. 299, 7.1.26.

Calling sequence:
ERFC (X,XLIMIT)

Contained in module: ERFC

Called by: CLIMIX DIFSNR PAVERG POUTAG POWER

Calls: NONE

Input arguments:

X	R*4	Lower limit on integration.
XLIMIT	R*4	Cut-off limit on argument beyond which the function value is zero.

Output arguments:

ERFC	R*4	Complimentary error function approximation.

5.14 POWER

Subprogram name: Subroutine POWER

Purpose: Calculates the long term RSL distribution of the troposcatter signal for the specified climate type. It also calculates and prints out the long term distribution of the SNR per diversity branch for a desired service probability.

Calling sequence:

```
CALL POWER (JPOW,ASEP,TAU22,TAU23,RH1,ELOSS,ASNR,BWT,BWR, PTYPE)
```

Contained in module: POWER

Called by: TROPO

Calls: AVTER CLIME CLIMIL CLIMIX ERFC

Input arguments:

JPOW	R*8	Interference signal power density in dBm/Hz.
ASEP	R*4	Separation between receive antennas in meters.
PTYPE	I*2	Variable which indicates whether propagation mechanism is pure troposcatter (0 or 10) or mixed troposcatter-diffraction (1 or 11).
BWT	R*4	Transmit antenna beamwidth in degrees.
BWR	R*4	Receive antenna beamwidth in degrees.

Output arguments:

ELOSS	R*8	Upper beam squint loss for scatter component in dB or sidelobe loss for interference.
TAU22	R*8	Delay spread on lower beam in nsec.
TAU23	R*8	Delay spread on upper beam in nsec.
RH1	R*8	Correlation coeffiecient between lower and upper beam.
ASNR	R*4	Median and/or yearly average value of troposcatter signal SNR in dB.

Global variables input from common:

AA	/PROPAR/	R*4	TROCOM.INC
	Atmospheric absorption loss in dB.		
ALFA0	/PATHGE/	R*4	TROCOM.INC
	Minimum transmit antenna elevation angle measured from transmitter-to-receiver line to transmit horizon line in radians.		
BETA0	/PATHGE/	R*4	TROCOM.INC
	Minimum receive antenna elevation angle measured from receiver-to-transmitter line to receiver horizon line in radians.		
BW	/SYSTRN/	R*4	TROCOM.INC
	Bandwidth in Hertz. Default is 7 MHz.		
C	/PDATA/	R*4	PDATA.INC

	Error output unit.		
PHDIV	/MCOM4/	R*4	MCOM.INC
	Squint angle between upper and lower receiver beams in radians. Default is beamwidth.		
THER	/PATHGE/	R*4	TROCOM.INC
	Radio horizon elevation angle at receive site in radians.		
THETAO	/PATHGE/	R*4	TROCOM.INC
	Scattering angle at bottom of common volume in radians.		

Global variables output to common:

CORRLT	/CPLOSS/	R*4	CPL.INC
	Correlation coefficient for long term variability of lower and upper beams.		

5.13 LTCORR

Subprogram name: Subroutine LTCORR

Purpose: Computes correction factor for SNR due to decorrelation of long term variability between upper and lower beams. (Angle diversity only.)

Calling sequence:
```
CALL LTCORR (CORFAC)
```

Contained in module: LTCORR

Called by: TROPO

Calls: NONE

Input arguments:
NONE

Output arguments:

CORFAC	R*4	Correction factor computed by LTCORR. CORFAC is used in subroutine BERCAL to scale STSNR multiplicatively when angle diversity is used.

Global variables input from common:

A	/PATHGE/	R*4	TROCOM.INC
	Effective earth radius in meters.		
ALFA0	/PATHGE/	R*4	TROCOM.INC
	Minimum transmit antenna elevation angle measured from transmitter-to-receiver line to transmit horizon line in radians.		
D	/PATHGE/	R*4	TROCOM.INC
	Great circle distance between transmitter and receiver measured at sea level in meters.		
DIVTYP	/MCOM2/	I*2	MCOM.INC
	Diversity configuration indicator. Default is 0. 0 = 2 receive antennas; 2S 2S/2F 2S/2A 2S/2A/2F 1 = 1 receive antenna; 2A 2F 2F/2A 2 = 2 transmit, 2 receive antennas; 2S/2P 2S/2P/2A 3 = Not used 4 = User supplied parameters S = Space F = Frequency A = Angle P = Polarization		
HCOM	/PATHGE/	R*4	TROCOM.INC
	Effective height of the bottom of the common volume in meters.		
HRN	/PATHGE/	R*4	TROCOM.INC
	Receive antenna height above sea level in meters.		
LERR	/LUNS/	I*2	LUNS.INC

```
                         Q(.,7)  Power on diffraction path vs. delay
                      For DIVTYP = 1:
                         Q(.,1)  Power on lower beam vs. delay.
                         Q(.,2)  Correlation between lower and
                                 upper beam vs. delay.
                         Q(.,3)  Power on upper beam vs. delay
                         Q(.,7)  Power on diffraction path vs. delay.
                      For DIVTYP = 2:
                         Q(.,1)  Power on path 1 (lower beam) vs. delay.
                         Q(.,2)  Correlation between convergent paths
                                 (lower beam) vs. delay.
                         Q(.,3)  Correlation between divergent paths
                                 (lower beam) vs. delay.
                         Q(.,4)  Correlation between parallel paths
                                 (lower beam) vs. delay.
                         Q(.,5)  Correlation between crossing paths
                                 (lower beam) vs. delay.
                         Q(.,6)  Power on path of upper beam vs. delay.
                         Q(.,7)  Power on diffraction path vs. delay.
QCORR(NCORMX)         /PDATA/          R*4     PDATA.INC
                      Contains elements of covariance matrix, ie, powers and
                      correlations.
                      For DIVTYP = 0:
                         QCORR(1) Power on lower beam
                         QCORR(2) Correlation coefficient between lower
                                  and upper beam.
                         QCORR(3) Correlation coefficient between lower
                                  beams of antennas 1 and 2
                         QCORR(4) Power on upper beam.
                      For DIVTYP = 1:
                         QCORR(1) Power on lower beam
                         QCORR(2) Correlation coefficient between lower
                                  and upper beam.
                         QCORR(3) Power on upper beam.
                      For DIVTYP = 2:
                         QCORR(1) Power on path 1 (lower beam)
                         QCORR(2) Correlation coefficient between convergent
                                  paths.
                         QCORR(3) Correlation coefficient between divergent
                                  paths.
                         QCORR(4) Correlation coefficient between parallel
                                  paths.
                         QCORR(5) Correlation coefficient between crossing
                                  paths.
                         QCORR(6) Power on upper beam.
TEMPA(NCORMX)         /PDATA/          R*4     PDATA.INC
                      Array of average troposcatter signal delays for each
                      beam relative to straight line in seconds.
```

```
C                  /PDATA/        R*4     PDATA.INC
                   Proportionality constant in troposcatter path loss
                   calculation.
DELPB              /PDATA/        R*4     PDATA.INC
                   Resolution of a delay cell in seconds.
FSEP               /PDATA/        R*4     PDATA.INC
                   Frequency separation for uncorrelated frequency
                   diversity in Hz.
HCOM               /PATHGE/       R*4     TROCOM.INC
                   Effective height of the bottom of the common volume in
                   meters.
I1CORR(NCORMX)     /PDATA/        I*2     PDATA.INC
                   Array of receiving beams involved in the correlation
                   calculations.
I2CORR(NCORMX)     /PDATA/        I*2     PDATA.INC
                   Array of receiving beams involved in the correlation
                   calculations.
IBLOSS(6)          /CPLOSS/       I*2     CPL.INC
                   Beam number corresponding to CPL(I).
ICPL               /CPLOSS/       I*2     CPL.INC
                   Coupling loss count.
INEG               /PDATA/        I*2     PDATA.INC
                   Number of negative delay cells encountered in
                   troposcatter integration.  It is an error if INEG > 0.
IPOS               /PDATA/        I*2     PDATA.INC
                   Number of delay cells exceeding the last allocated
                   array element.  This number should be zero or small.
                   IPOS > 0 is not a serious error unless the delay
                   profile calculated has a clear peak in the last delay
                   cell.
IPROF(NCORMX)      /PDATA/        I*2     PDATA.INC
                   0 if the Ith correlation not wanted, 1 if wanted.
ITER               /PDATA/        I*4     PDATA.INC
                   Number of integration cells in the common volume
                   integration.
NCORR              /PDATA/        I*2     PDATA.INC
                   Number of receive port correlations.
PLOSSM             /PDATA/        R*4     PDATA.INC
                   Troposcatter path loss from approximate analytic
                   expression.
Q(NDELMX,NCORMX)   /PDATA/        R*4     PDATA.INC
                   Matrix of troposcatter signal power and correlation
                   per unit delay profiles.
                   For DIVTYP = 0:
                      Q(.,1)  Power on lower beam vs. delay.
                      Q(.,2)  Correlation between lower and
                              upper beam vs. delay.
                      Q(.,3)  Correlation between lower beams
                              in antennas 1 & 2 vs. delay.
                      Q(.,4)  Power on upper beam vs. delay.
```

	Number of receive ports.			
NT	/SYSTRN/	I*2	TROCOM.INC	
	Number of transmit ports.			
PSIRAO(NRMX)	/ANTENN/	R*4	TROCOM.INC	
	Array of receiver beam azimuths in radians.			
PSIREO(NRMX)	/ANTENN/	R*4	TROCOM.INC	
	Array of receiver beam boresight elevations above radio horizon in radians, ie, angle at which each antenna is aimed relative to the horizon. PSIREO(1) is the main receive antenna.			
PSITAO(NTMX)	/ANTENN/	R*4	TROCOM.INC	
	Array of transmitter beam azimuths in radians.			
PSITEO(NTMX)	/ANTENN/	R*4	TROCOM.INC	
	Array of transmitter beam boresight elevations above radio horizon in radians, ie, angle at which each antenna is aimed relative to the horizon. PSITEO(1) is the main transmit antenna.			
SCPARM	/PROPAR/	R*4	TROCOM.INC	
	Wavenumber spectrum slope parameter M. Default is 3.66.			
THET	/PATHGE/	R*4	TROCOM.INC	
	Radio horizon elevation angle at transmit site in radians.			
THETAO	/PATHGE/	R*4	TROCOM.INC	
	Scattering angle at bottom of common volume in radians.			
TWOPI	/CONSTA/	R*4	CONSTANTS.INC	
	2 X Pi = 6.283185307.			
URH(NR)	/PATHGE/	R*4	TROCOM.INC	
	Array of receive antennas horizontal offsets from great circle plane in meters.			
URL(NR)	/PATHGE/	R*4	TROCOM.INC	
	Array of receive antennas longitudinal offsets in meters.			
URV(NR)	/PATHGE/	R*4	TROCOM.INC	
	Array of receive antennas vertical offsets in meters.			
UTH(NT)	/PATHGE/	R*4	TROCOM.INC	
	Array of transmit antennas horizontal offsets in meters.			
UTL(NT)	/PATHGE/	R*4	TROCOM.INC	
	Array of transmit antennas longitudinal offsets in meters.			
UTV(NT)	/PATHGE/	R*4	TROCOM.INC	
	Array of transmit antennas vertical offsets in meters.			
WAVLEN	/SYSTRN/	R*4	TROCOM.INC	
	Wavelength in meters.			
Y1	/PATHGE/	R*4	TROCOM.INC	
	Maximum estimated integration length in Y-direction.			

Global variables output to common:

	Array of receiver antenna diameters in meters. AR(1) is equivalent to RDIAM in the input file.		
BETA0	/PATHGE/	R*4	TROCOM.INC
	Minimum receive antenna elevation angle measured from receiver-to-transmitter line to receiver horizon line in radians.		
BETA1	/PATHGE/	R*4	TROCOM.INC
	Maximum receive antenna elevation angle measured from receiver-to-transmitter line to top of common volume in radians.		
BW	/SYSTRN/	R*4	TROCOM.INC
	Bandwidth in Hertz. Default is 7 MHz.		
CO	/CONSTA/	R*4	CONSTANTS.INC
	Free space velocity of radio waves = 2.998E8 m/sec.		
D	/PATHGE/	R*4	TROCOM.INC
	Great circle distance between transmitter and receiver measured at sea level in meters.		
DELREF	/PDATA/	R*4	PDATA.INC
	Minimum delay through the lowest scattering point (relative to straight line delay) in seconds.		
ERR	/CONTROL/	R*4	TROCOM.INC
	Common volume integration resolution. Default is .001.		
HLOW	/PROPAR/	R*4	TROCOM.INC
	Lowest height above sea level at which CN2 is specified in meters.		
HTN	/PATHGE/	R*4	TROCOM.INC
	Transmit antenna height above sea level in meters.		
IBR(NRMX,NRMX)	/SYSTRN/	I*2	TROCOM.INC
	Channel complex-envelope correlation and cross-correlation calculation indicator array. 0 = No calculation 1 = Power (correlation) calculation only 2 = Power (correlation) per unit delay spectrum calculation		
IPOLR(NRMX)	/ANTENN/	I*2	TROCOM.INC
	Array of receiver antenna polarizations.		
IPOLT(NTMX)	/ANTENN/	I*2	TROCOM.INC
	Array of transmitter antenna polarizations.		
KPROF	/PROPAR/	I*2	TROCOM.INC
	Actual number of samples in height profile of structure constant CN2. Limited to NPROF samples.		
NACCU	/CONTRL/	I*2	TROCOM.INC
	Parameter used as truncation point for common volume integration termination. Default is 40.		
NCORMX	Parameter	I*2	TROPAR.INC
	Maximum number of correlations between receive ports.		
NDELMX	Parameter	I*2	TROPAR.INC
	Maximum number of delay bins in troposcatter power per unit delay profiles.		
NR	/SYSTRN/	I*2	TROCOM.INC

5.12 LOOPS

Subprogram name: Subroutine LOOPS

Purpose: This is the key routine performing the integration over the common volume to calculate received power vs. delay at all specified antenna ports and the convolutions between antenna ports vs. delay at all specified antenna ports.

Description: A certain amount of the code is keeping track of which antenna locations are different, eg, space diversity; which antenna beams point differently, ie, angle diversity; which correlations involve space-, angle-, or polarization diversity. The number of correlations is NCORR, and for each correlation, ICORR, the arrays I1CORR and I2CORR point to the receiving ports involved in the integration of correlation number ICORR. An analytical path loss estimate, PLOSSM, is evaluated. Power levels and correlation coefficients are stored in the array QCORR. Average delay (normalized) and delay spread are in the arrays TEMPA and TEMPB. The frequency separation which corresponds to a frequency correlation coefficient of .5 is evaluated.

Calling sequence:
    CALL LOOPS

Contained in module: LOOPS

Called by: TROPO

Calls: ANTPTR, BEAMPT, DELO, ERROR, FRQSEP, RGAIN, RIPROF, SINT, STEPAB, STEPY, STPPAR, TGAIN, TRLOSS

Input arguments:
    NONE

Output arguments:
    NONE

Global variables input from common:

A	/PATHGE/	R*4	TROCOM.INC	
	Effective earth radius in meters.			
ALFA0	/PATHGE/	R*4	TROCOM.INC	
	Minimum transmit antenna elevation angle measured from transmitter-to-receiver line to transmit horizon line in radians.			
ALFA1	/PATHGE/	R*4	TROCOM.INC	
	Maximum transmit antenna elevation angle measured from transmitter-to-receiver line to top of common volume in radians.			
AR(NRMX)	/ANTENN/	R*4	TROCOM.INC	

	Diffraction angle in radians.		
Y1	/PATHGE/	R*4	TROCOM.INC
	Maximum estimated integration length in Y-direction.		

ERR	/CONTROL/	R*4	TROCOM,INC
	Common volume integration resolution. Default is .001.		
HRN	/PATHGE/	R*4	TROCOM,INC
	Receive antenna height above sea level in meters.		
HTN	/PATHGE/	R*4	TROCOM,INC
	Transmit antenna height above sea level in meters.		
NR	/SYSTRN/	I*2	TROCOM,INC
	Number of receive ports.		
NT	/SYSTRN/	I*2	TROCOM,INC
	Number of transmit ports.		
PSIRAO(NRMX)	/ANTENN/	R*4	TROCOM,INC
	Array of receiver beam azimuths in radians.		
PSIREO(NRMX)	/ANTENN/	R*4	TROCOM,INC
	Array of receiver beam boresight elevations above radio horizon in radians, ie, angle at which each antenna is aimed relative to the horizon. PSIREO(1) is the main receive antenna.		
PSITAO(NTMX)	/ANTENN/	R*4	TROCOM,INC
	Array of transmitter beam azimuths in radians.		
PSITEO(NTMX)	/ANTENN/	R*4	TROCOM,INC
	Array of transmitter beam boresight elevations above radio horizon in radians, ie, angle at which each antenna is aimed relative to the horizon. PSITEO(1) is the main transmit antenna.		
SCPARM	/PROPAR/	R*4	TROCOM,INC
	Wavenumber spectrum slope parameter M. Default is 3.66.		
THER	/PATHGE/	R*4	TROCOM,INC
	Radio horizon elevation angle at receive site in radians.		
THET	/PATHGE/	R*4	TROCOM,INC
	Radio horizon elevation angle at transmit site in radians.		
THETAO	/PATHGE/	R*4	TROCOM,INC
	Scattering angle at bottom of common volume in radians.		

Global variables output to common:

ALFA1	/PATHGE/	R*4	TROCOM,INC
	Maximum transmit antenna elevation angle measured from transmitter-to-receiver line to top of common volume in radians.		
BETA1	/PATHGE/	R*4	TROCOM,INC
	Maximum receive antenna elevation angle measured from receiver-to-transmitter line to top of common volume in radians.		
HHIGH	/PATHGE/	R*4	TROCOM,INC
	Effective height of the top of the common volume in meters.		
PHI	/PATHGE/	R*4	TROCOM,INC

5.11 INTLIM

Subprogram name: Subroutine INTLIM

Purpose: Calculates the limits of common volume integration. Calculates the maximum value, ALFA1, of the angle ALFA, the maximum value, BETA1, of the angle BETA, the maximum height of the common volume, HHIGH, and the maximum value Y1 of the Y coordinate (perpendicular to the great circle plane.)

Calling sequence:
CALL INTLIM

Contained in module: INTLIM

Called by: TROPO

Calls: NONE

Input arguments:
NONE

Output arguments:
NONE

Global variables input from common:

A	/PATHGE/	R*4	TROCOM.INC
	Effective earth radius in meters.		
ALFA0	/PATHGE/	R*4	TROCOM.INC
	Minimum transmit antenna elevation angle measured from transmitter-to-receiver line to transmit horizon line in radians.		
BETA0	/PATHGE/	R*4	TROCOM.INC
	Minimum receive antenna elevation angle measured from receiver-to-transmitter line to receiver horizon line in radians.		
D	/PATHGE/	R*4	TROCOM.INC
	Great circle distance between transmitter and receiver measured at sea level in meters.		
DELTAR(NRMX)	/ANTENN/	R*4	TROCOM.INC
	3dB half-beamwidth of each receive antenna in radians.		
DELTAT(NTMX)	/ANTENN/	R*4	TROCOM.INC
	3dB half-beamwidth of each transmit antenna in radians.		
DR	/PATHGE/	R*4	TROCOM.INC
	Receiver distance to minimum scattering point in meters.		
DT	/PATHGE/	R*4	TROCOM.INC
	Transmit antenna distance to minimum scattering point in meters.		

5.10 HORANG

Subprogram name: Subroutine HORANG

Purpose: Compute horizon elevation angle from given horizon distance and height.

Calling sequence:
```
     CALL HORANG (A, D, H, T)
```

Contained in module: HORANG

Called by: TANGL, TRANSF

Calls: NONE

Input arguments:

A	R*4	Radius of the earth plus height of the antenna in meters.
D	R*4	Horizon distance in meters.
H	R*4	Horizon height above the antenna height in meters.

Output arguments:

T	R*4	Horizon elevation angle (position above grazing) in radians.

5.9 GPATT

Subprosram name: Subroutine GPATT

Purpose: Voltase directional pattern type 2J1(X) / X. Calculates the voltase sain pattern up to and includins the first sidelobe usins the formula:

G = 2 * J1(X) / X,

Where:

X is PI * AD * SIN(PSI) / WAVLEN
AD is the antenna diameter
PSI is the ansle

To use other antenna patterns, GPATT may be replaced by other subroutines in RGAIN and TGAIN.

Callins sequence:

```
CALL GPATT (AD, WAVLEN, PSI, Y)
```

Contained in module: GPATT

Called by: RGAIN, TGAIN

Calls: NONE

Input arsuments:

AD	R*4	Antenna diameter in meters.
WAVLEN	R*4	Wavelensth in meters.
PSI	R*4	Off-boresisht ansle in radians.

Output arsuments:

Y	R*4	Relative voltase sain at off-boresisht ansle PSI.

Global variables input from common:

PI	/CONSTA/	R*4	CONSTANTS.INC
	Constant Pi = 3.141592654.		

5.8 FRQSEP

Subprogram name: Subroutine FRQSEP

Purpose: Compute minimum frequency separation required for uncorrelated frequency diversity operation.

Calling sequence:
CALL FRQSEP (N, Q, DELPB, BW, FSEP)

Contained in module: FRQSEP

Called by: LOOPS

Calls: NONE

Input arguments:

N	I*2	Number of points in DFT.
Q(N)	R*4	Power per unit delay profile.
DELPB	R*4	Delay interval in seconds.
BW	R*4	Signal bandwidth in Hz.
FSEP	R*4	Estimate of coherance bandwidth in Hz.

Output arguments:

FSEP	R*4	Minimum frequency separation in Hz.

	Proportionality constant in troposcatter path loss calculation.		
CO	/CONSTA/	R*4	CONSTANTS.INC
	Free space velocity of radio waves = 2.998E8 m/sec.		
CORRLT	/CPLOSS/	R*4	CPL.INC
	Correlation coefficient for long term variability of lower and upper beams.		
CPL(6)	/CPLOSS/	R*4	CPL.INC
	Aperture-to-medium coupling loss array in dB.		
D	/PATHGE/	R*4	TROCOM.INC
	Great circle distance between transmitter and receiver measured at sea level in meters.		
DELPB	/PDATA/	R*4	PDATA.INC
	Resolution of a delay cell in seconds.		
DELREF	/PDATA/	R*4	PDATA.INC
	Minimum delay through the lowest scattering point (relative to straight line delay) in seconds.		
DELTAR(NRMX)	/ANTENN/	R*4	TROCOM.INC
	3dB half-beamwidth of each receive antenna in radians.		
DELTAT(NTMX)	/ANTENN/	R*4	TROCOM.INC
	3dB half-beamwidth of each transmit antenna in radians.		
DIVTYP	/MCOM2/	I*2	MCOM.INC
	Diversity configuration indicator. Default is 0. 0 = 2 receive antennas; 2S 2S/2F 2S/2A 2S/2A/2F 1 = 1 receive antenna; 2A 2F 2F/2A 2 = 2 transmit, 2 receive antennas; 2S/2P 2S/2P/2A 3 = Not used 4 = User supplied parameters S = Space F = Frequency A = Angle P = Polarization		
DLR	/PATHGE/	R*4	TROCOM.INC
	Distance from receiver to radio horizon in meters.		
DLT	/PATHGE/	R*4	TROCOM.INC
	Distance from transmitter to radio horizon in meters.		
DRATE	/MCOM4/	R*4	MCOM.INC
	Data rate in bits/second. Default is 6.6E6.		
ERFAC	/PROPAR/	R*4	TROCOM.INC
	Yearly median value of effective earth radius factor k in kilometers. Default is 1.33.		
F	/SYSTRN/	R*4	TROCOM.INC
	Operating frequency in Hz. Model is accurate between 100MHz and 10GHz.		
GRDB(NRMX)	/ANTENN/	R*4	TROCOM.INC
	Gain of each receive antenna in dBi.		
GTDB(NTMX)	/ANTENN/	R*4	TROCOM.INC
	Gain of each transmit antenna in dBi.		
HI(155)	/MCOM4/	R*4	MCOM.INC
	Array containing NPM(1) evenly-spaced terrain elevation data (in meters) between transmitter and		

	first obstacle followed by NPM(2) evenly-spaced terrain elevation data between first and second obstacle, etc., ending with NPM(NOBS+1) evenly-spaced terrain elevation data between last obstacle and receive site. The data should be selected such that: HI(1) = Terrain elevation above sea level at transmit site (HTO). HI(NPM(I)) = HI (NPM(I)+1) = Elevation of Ith obstacle above sea level (HL(I)). HI(NPM(NOBS+1)) = Terrain elevation above sea level at receive site (HRO). In MDTS, HI is used as work space. It is equivalenced to local arrays.		
HRN	/PATHGE/	R*4	TROCOM.INC
	Receive antenna height above sea level in meters.		
HTN	/PATHGE/	R*4	TROCOM.INC
	Transmit antenna height above sea level in meters.		
IBLOSS(6)	/CPLOSS/	I*2	CPL.INC
	Beam number corresponding to CPL(I).		
ICPL	/CPLOSS/	I*2	CPL.INC
	Coupling loss count.		
ITER	/PDATA/	I*4	PDATA.INC
	Number of integration cells in the common volume integration.		
KLIMAT	/PROPAR/	I*2	TROCOM.INC
	Climate zone indicator. Default is 0. 0 = User supplied climate NBS TN101 climates 1 = Continental temperate (CT) 2 = Maritime temperate overland (MTL) 3 = Maritime temperate oversea (MTS) 4 = Maritime subtropical overland (MSL) 5 = Continental temperate time block 2 (CT2) (winter afternoon hours) - formerly Maritime subtropical oversea (MSS) 6 = Desert, Sahara (DS) 7 = Equatorial (EQU) 8 = Continental subtropical (CS) MIL-HDBK-417 climates 9 = Continental temperate (CT) 10 = Maritime temperate overland (MTL) 11 = Maritime temperate oversea (MTS) 12 = Maritime subtropical (MS) 13 = Desert, Sahara (DS) 14 = Equatorial (EQU) 15 = Continental subtropical (CS) 16 = Mediterranean (MED) 17 = Polar (POL)		
LERR	/LUNS/	I*2	LUNS.INC
	Error output unit.		

```
LOUT             /LUNS/          I*2     LUNS.INC
                 FOR002.DAT output unit number.
MDIST            /ERAD/          I*2     ERAD.INC
                 Multipath distribution indicator.
                         0 = Only median multipath spread used(default)
                         1 = Multipath distribution used.  (Option not
                             currently available.)
NCORR            /PDATA/         I*2     PDATA.INC
                 Number of receive port correlations.
NDELMX           Parameter       I*2     TROPAR.INC
                 Maximum number of delay bins in troposcatter power per
                 unit delay profiles.
NFIG             /MCOM4/         R*4     MCOM.INC
                 Receiver noise figure in dB.  Default is 4dB.
NOBS             /MCOM2/         I*2     MCOM.INC
                 Number of diffraction obstacles. Maximum is 3,
                 default is 1.
NPM(5)           /MCOM2/         I*2     MCOM.INC
                 Array containing number of terrain elevation data
                 points for calculation of effective antenna heights
                 for each section of the diffraction path.
NRAD             /ERAD/          I*2     ERAD.INC
                 ERFAC indicator and loop counter.  Default is 1.
NTERR            /MCOM2/         I*2     MCOM.INC
                 Control parameter for entry or calculation of
                 effective antenna heights (HTE, HRE) and effective
                 obstacle heights above average terrain elevation
                 (HLEF).
                         0 = HTE and HRE supplied directly
                         1 = AVETX and AVERX supplied
                         2 = HI(.) supplied
PRAD(3)          /ERAD/          R*4     ERAD.INC
                 Fraction of time effective earth radius factor is
                 greater than ERFAC; Probability that effective earth
                 radius factor is not exceeded.
                         For NRAD = 1    PRAD = 0.5
                                  = 2         = 0.1
                                  = 3         = 0.01
PSIREO(NRMX)     /ANTENN/        R*4     TROCOM.INC
                 Array of receiver beam boresight elevations above
                 radio horizon in radians, ie, angle at which each
                 antenna is aimed relative to the horizon.  PSIREO(1)
                 is the main receive antenna.
PSITEO(NTMX)     /ANTENN/        R*4     TROCOM.INC
                 Array of transmitter beam boresight elevations above
                 radio horizon in radians, ie, angle at which each
                 antenna is aimed relative to the horizon.  PSITEO(1)
                 is the main transmit antenna.
PXMIT            /MCOM4/         R*4     MCOM.INC
                 Rated transmission power in dBm.  Default is 70dBm.
```

```
          QCORR(NCORMX)    /PDATA/          R*4     PDATA.INC
                           Contains elements of covariance matrix, ie, powers and
                           correlations.
                           For DIVTYP = 0:
                              QCORR(1) Power on lower beam
                              QCORR(2) Correlation coefficient between lower
                                       and upper beam.
                              QCORR(3) Correlation coefficient between lower
                                       beams of antennas 1 and 2
                              QCORR(4) Power on upper beam.
                           For DIVTYP = 1:
                              QCORR(1) Power on lower beam
                              QCORR(2) Correlation coefficient between lower
                                       and upper beam.
                              QCORR(3) Power on upper beam.
                           For DIVTYP = 2:
                              QCORR(1) Power on path 1 (lower beam)
                              QCORR(2) Correlation coefficient between convergent
                                       paths.
                              QCORR(3) Correlation coefficient between divergent
                                       paths.
                              QCORR(4) Correlation coefficient between parallel
                                       paths.
                              QCORR(5) Correlation coefficient between crossing
                                       paths.
                              QCORR(6) Power on upper beam.
          RLL              /SYSTRN/         R*4     TROCOM.INC
                           Receiver line losses in dB.  Default is 0 dB.
          SP               /MCOM4/          R*4     MCOM.INC
                           Service probability.  Default is .95.
          SPREAD(NCORMX)   /PDATA/          R*4     PDATA.INC
                           Array of delay spreads (2-sigma) for each beam in
                           seconds.
          TEMPA(NCORMX)    /PDATA/          R*4     PDATA.INC
                           Array of average troposcatter signal delays for each
                           beam relative to straight line in seconds.
          THER             /PATHGE/         R*4     TROCOM.INC
                           Radio horizon elevation angle at receive site in
                           radians.
          THET             /PATHGE/         R*4     TROCOM.INC
                           Radio horizon elevation angle at transmit site in
                           radians.
          TLL              /SYSTRN/         R*4     TROCOM.INC
                           Transmitter line losses in dB.  Default is 0 dB.

     Global variables output to common:
          AVERX            /MCOM4/          R*4     MCOM.INC
                           Average terrain elevation above sea level between
                           receive site and radio horizon, in meters.
          AVETX            /MCOM4/          R*4     MCOM.INC
```

```
                                Average terrain elevation above sea level between
                                transmit site and radio horizon, in meters.
DE                              /SUMP/          R*4     CURVE.INC
                                Effective distance for troposcatter path in
                                kilometers.
DSP1(3)                         /SUMP/          R*4     CURVE.INC
                                Lower beam troposcatter signal RMS delay spread in
                                nanoseconds for percentiles 50, 90 and 99.
DSP2(3)                         /SUMP/          R*4     CURVE.INC
                                Upper beam troposcatter signal RMS delay spread in
                                nanoseconds for percentiles 50, 90 and 99.
HRE                             /MCOM4/         R*4     MCOM.INC
                                Effective receiver antenna height above average
                                terrain elevation in meters.
HTE                             /MCOM4/         R*4     MCOM.INC
                                Effective transmitter antenna height above average
                                terrain elevation in meters.
JQ2M                            /MCOM4/         I*2     MCOM.INC
                                Pointer to centroid of lower beam troposcatter signal
                                power per unit delay profile.
KGAIN                           /RZ/            I*2     RZ.INC
                                Integer ratio of bandwidth to data rate.
MODPAT                          /MCOM2/         I*2     MCOM.INC
                                Propagation/modem flag to select calculation mode.
                                Default is 1.
                                        0 = Propagation only
                                        1 = Propagation + MD-918 modem
                                        2 = Propagation + AN/TRC-170 or DAR modem
                                        3 = Propagation + user-defined modem
NDELQ                           /MCOM4/         I*2     MCOM.INC
                                Number of non-zero elements of troposcatter power per
                                unit delay profiles Q(NDELQ,1).
PLOSS1                          /ERAD/          R*4     ERAD.INC
                                Reference troposcatter path loss in dB on lower beam
                                for NRAD equals 1.
Q(NDELMX,NCORMX) /PDATA/        R*4     PDATA.INC
                                Matrix of troposcatter signal power and correlation
                                per unit delay profiles.
                                For DIVTYP = 0:
                                   Q(.,1)  Power on lower beam vs. delay.
                                   Q(.,2)  Correlation between lower and
                                           upper beam vs. delay.
                                   Q(.,3)  Correlation between lower beams
                                           in antennas 1 & 2 vs. delay.
                                   Q(.,4)  Power on upper beam vs. delay.
                                   Q(.,7)  Power on diffraction path vs. delay
                                For DIVTYP = 1:
                                   Q(.,1)  Power on lower beam vs. delay.
                                   Q(.,2)  Correlation between lower and
                                           upper beam vs. delay.
```

Q(.,3) Power on upper beam vs. delay
Q(.,7) Power on diffraction path vs. delay.
For DIVTYP = 2:
Q(.,1) Power on path 1 (lower beam) vs. delay.
Q(.,2) Correlation between convergent paths (lower beam) vs. delay.
Q(.,3) Correlation between divergent paths (lower beam) vs. delay.
Q(.,4) Correlation between parallel paths (lower beam) vs. delay.
Q(.,5) Correlation between crossing paths (lower beam) vs. delay.
Q(.,6) Power on path of upper beam vs. delay.
Q(.,7) Power on diffraction path vs. delay.

STSNR /SUMP/ R*4 SUMP.INC
Standard deviation of troposcatter signal long-term SNR distribution in dB.

TDIFF /MCOM4/ R*4 MCOM.INC
Normalized relative delay between lower and upper beam.

TROLOS(3) /SUMP/ R*4 CURVE.INC
Median troposcatter path loss in dB for each value in ERFAC distribution.

TRORSL(3) /SUMP/ R*4 CURVE.INC
Median troposcatter RSL in dBm for each value in ERFAC distribution.

5.15 RGAIN

Subprogram name: Function RGAIN

Purpose: Relative voltage gain for receive aperture I at the off-boresight angle PSI.

Calling sequence:
RGAIN (I, PSI)

Contained in module: RGAIN

Called by: DIFSNR, LOOPS

Calls: GPATT

Input arguments:

I	I*2	Receiving aperture index.
PSI	R*4	Off-boresight angle in radians.

Output arguments:

RGAIN	R*4	Relative voltage gain for given receive aperture.

Global variables input from common:

AR(NRMX)	/ANTENN/	R*4	TROCOM.INC
	Array of receiver antenna diameters in meters. AR(1) is equivalent to RDIAM in the input file.		
WAVLEN	/SYSTRN/	R*4	TROCOM.INC
	Wavelength in meters.		

5.16 RIPROF

Subprogram name: Subroutine *RIPROF*

Purpose: Calculates a normalized CN2 value for a given point ALFA, BETA. Used when refractive index profile is input by the user.

Calling sequence:
CALL RIPROF (HEIGHT, CN2LOC)

Contained in module: RIPROF

Called by: LOOPS

Calls: ERROR

Input arguments:

HEIGHT	R*4	Height above sea level of the current scattering point.

Output arguments:

CN2LOC	R*4	Normalized CN2 value.

Global variables input from common:

CN2(NPROF)	/PROPAR/	R*4	TROCOM.INC
	The atmospheric structure constant height profile in meters to the -2/3 power.		
DELH	/PROPAR/	R*4	TROCOM.INC
	Spacing of CN2 samples in meters.		
KPROF	/PROPAR/	I*2	TROCOM.INC
	Actual number of samples in height profile of structure constant CN2. Limited to NPROF samples.		

5.17 STEPAB

Subprogram name: Function STEPAB

Purpose: Calculates step size of alpha or beta for a given scattering point.

Calling sequence:
STEPAB (THETA)

Contained in module: STEPAB

Called by: LOOPS

Calls: NONE

Input arguments:

THETA	R*4	Scattering angle at bottom of common volume in radians.

Output arguments:

STEPAB	R*4	Step size of alpha or beta.

Global variables input from common:

BEAM	/STPCOM/	R*4	STPCOM.INC
	Parameter for determining azimuth and elevation angle step size in common volume integration.		
TFAK	/STPCOM/	R*4	STPCOM.INC
	Constant for common volume integration.		

5.18 STEPY

Subprogram name: Function STEPY

Purpose: Calculates the step size in the Y direction.

Calling sequence:
STEPY (THETA, Y, ROT, ROR)

Contained in module: STEPY

Called by: LOOPS

Calls: NONE

Input arguments:

THETA	R*4	Scattering angle at point of integration.
Y	R*4	Y coordinate.
ROT	R*4	Distance from transmitter to point of integration.
ROR	R*4	Distance from receiver to point of integration.

Output arguments:

STEPY	R*4	Step size in the Y direction.

Global variables input from common:

TFAKY1	/STPCOM/	R*4	STPCOM.INC
	Constant for common volume integration.		
TFAKY2	/STPCOM/	R*4	STPCOM.INC
	Constant for common volume integration.		
TFAKY3	/STPCOM/	R*4	STPCOM.INC
	Constant for common volume integration.		
TFAKY4	/STPCOM/	R*4	STPCOM.INC
	Constant for common volume integration.		

5.19 STPPAR

Subprogram name: Subroutine STPPAR

Purpose: Initializes parameters required to determine step size of alpha, beta and Y in the common volume integration. Refines step size for space diversity correlation.

Calling sequence:
CALL STPPAR

Contained in module: STPPAR

Called by: LOOPS

Calls: NONE

Input arguments:
NONE

Output arguments:
NONE

Global variables input from common:

```
DELTAR(NRMX)    /ANTENN/      R*4    TROCOM.INC
                3dB half-beamwidth of each receive antenna in radians.
DELTAT(NTMX)    /ANTENN/      R*4    TROCOM.INC
                3dB half-beamwidth of each transmit antenna in
                radians.
DR              /PATHGE/      R*4    TROCOM.INC
                Receiver distance to minimum scattering point in
                meters.
DT              /PATHGE/      R*4    TROCOM.INC
                Transmit antenna distance to minimum scattering point
                in meters.
ERR             /CONTROL/     R*4    TROCOM.INC
                Common volume integration resolution. Default is .001.
IBR(NRMX,NRMX)  /SYSTRN/      I*2    TROCOM.INC
                Channel complex-envelope correlation and
                cross-correlation calculation indicator array.
                        0 = No calculation
                        1 = Power (correlation) calculation only
                        2 = Power (correlation) per unit delay
                            spectrum calculation
IPOLR(NRMX)     /ANTENN/      I*2    TROCOM.INC
                Array of receiver antenna polarizations.
NR              /SYSTRN/      I*2    TROCOM.INC
                Number of receive ports.
NT              /SYSTRN/      I*2    TROCOM.INC
                Number of transmit ports.
```

SCPARM	/PROPAR/	R*4	TROCOM.INC
	Wavenumber spectrum slope parameter M. Default is 3.66.		
TWOPI	/CONSTA/	R*4	CONSTANTS.INC
	2 X Pi = 6.283185307.		
URH(NR)	/PATHGE/	R*4	TROCOM.INC
	Array of receive antennas horizontal offsets from great circle plane in meters.		
UTH(NT)	/PATHGE/	R*4	TROCOM.INC
	Array of transmit antennas horizontal offsets in meters.		
WAVLEN	/SYSTRN/	R*4	TROCOM.INC
	Wavelength in meters.		

Global variables output to common:

BEAM	/STPCOM/	R*4	STPCOM.INC
	Parameter for determining azimuth and elevation angle step size in common volume integration.		
TFAK	/STPCOM/	R*4	STPCOM.INC
	Constant for common volume integration.		
TFAKY1	/STPCOM/	R*4	STPCOM.INC
	Constant for common volume integration.		
TFAKY2	/STPCOM/	R*4	STPCOM.INC
	Constant for common volume integration.		
TFAKY3	/STPCOM/	R*4	STPCOM.INC
	Constant for common volume integration.		
TFAKY4	/STPCOM/	R*4	STPCOM.INC
	Constant for common volume integration.		

5.20 TGAIN

Subprogram name: Function TGAIN

Purpose: Calculates relative voltage gain for transmit aperture I at the off-boresight angle PSI.

Calling sequence:
TGAIN (I, PSI)

Contained in module: TGAIN

Called by: DIFSNR, LOOPS

Calls: GPATT

Input arguments:

I	I*2	Transmit aperture index.
PSI	R*4	Off-boresight angle in radians.

Output arguments:

TGAIN	R*4	Relative voltage gain for given transmit aperture.

Global variables input from common:

AT(NTMX)	/ANTENN/	R*4	TROCOM.INC
	Array of transmitter antenna diameters in meters. AT(1) is equivalent to TDIAM in the input file.		
WAVLEN	/SYSTRN/	R*4	TROCOM.INC
	Wavelength in meters.		

5.21 TRANSF

Subprogram name: Subroutine TRANSF

Purpose: Transform angles and distances to effective earth radius and calculate scattering point assuming that at each site all antennas have a common horizon and minimum scattering point. The different antenna heights are ignored in the calculation of the common volume.

Calling sequence:
CALL TRANSF

Contained in module: TRANSF

Called by: TROPO

Calls: ERROR, HORANG

Input arguments:
NONE

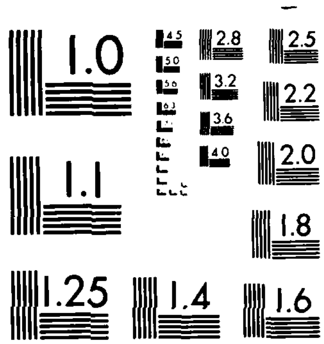
Output arguments:
NONE

Global variables input from common:

A	/PATHGE/	R*4	TROCOM.INC
	Effective earth radius in meters.		
A0	/CONSTA/	R*4	CONSTANTS.INC
	Radius of the earth in meters = 6367650.		
D	/PATHGE/	R*4	TROCOM.INC
	Great circle distance between transmitter and receiver measured at sea level in meters.		
DELTAR(NRMX)	/ANTENN/	R*4	TROCOM.INC
	3dB half-beamwidth of each receive antenna in radians.		
DELTAT(NTMX)	/ANTENN/	R*4	TROCOM.INC
	3dB half-beamwidth of each transmit antenna in radians.		
DLR	/PATHGE/	R*4	TROCOM.INC
	Distance from receiver to radio horizon in meters.		
DLT	/PATHGE/	R*4	TROCOM.INC
	Distance from transmitter to radio horizon in meters.		
ERFAC	/PROPAR/	R*4	TROCOM.INC
	Yearly median value of effective earth radius factor k in kilometers. Default is 1.33.		
ITOFF	/PROPAR/	I*2	TROCOM.INC
	Control indicator for entry or calculation of transmit/receive radio horizon angles THET and THER. Values have following meanings: 0 = Use input THET, THER as reference and actual horizon (default).		

AD-A151 983 DIGITAL TROPOSCATTER PERFORMANCE MODEL: SOFTWARE DOCUMENTATION(U) SIGNATRON INC LEXINGTON MA P MONSEN ET AL. 28 NOV 83 A-288-16 DCA100-80-C-0030 2/4

UNCLASSIFIED F/G 9/2 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

1 = Calculate reference horizon using HORANG and K equals 1.33. (Assuming DLT and DLR are non-zero.) (Option not available.)
2 = Calculate reference horizon using HORANG and K equals ERFAC. (Assuming DLT and DLR are non-zero.)
3 = Do not change reference horizons from previous run. (Option not available.)

NR /SYSTRN/ I*2 TROCOM.INC
Number of receive ports.

NT /SYSTRN/ I*2 TROCOM.INC
Number of transmit ports.

THER /PATHGE/ R*4 TROCOM.INC
Radio horizon elevation angle at receive site in radians.

THET /PATHGE/ R*4 TROCOM.INC
Radio horizon elevation angle at transmit site in radians.

Global variables output to common:

ALFA0 /PATHGE/ R*4 TROCOM.INC
Minimum transmit antenna elevation angle measured from transmitter-to-receiver line to transmit horizon line in radians.

BETA0 /PATHGE/ R*4 TROCOM.INC
Minimum receive antenna elevation angle measured from receiver-to-transmitter line to receiver horizon line in radians.

DR /PATHGE/ R*4 TROCOM.INC
Receiver distance to minimum scattering point in meters.

DT /PATHGE/ R*4 TROCOM.INC
Transmit antenna distance to minimum scattering point in meters.

HCOM /PATHGE/ R*4 TROCOM.INC
Effective height of the bottom of the common volume in meters.

HLR /PATHGE/ R*4 TROCOM.INC
Receiver radio horizon elevation above sea level in meters.

HLT /PATHGE/ R*4 TROCOM.INC
Transmit radio horizon elevation above sea level in meters.

HRN /PATHGE/ R*4 TROCOM.INC
Receive antenna height above sea level in meters.

HTN /PATHGE/ R*4 TROCOM.INC
Transmit antenna height above sea level in meters.

IRF /PATHGE/ I*2 TROCOM.INC
Parameter which indicates whether reference horizon elevation angles have been calculated (IRF = 1) in

	previous run. It has meaning only when JTOFF = 3.		
PHI	/PATHGE/	R*4	TROCOM.INC
	Diffraction angle in radians.		
PHIR	/PATHGE/	R*4	TROCOM.INC
	Receive angular distance to minimum scattering point in radians.		
PHIT	/PATHGE/	R*4	TROCOM.INC
	Transmit angular distance to minimum scattering point in radians.		
PSIREO(NRMX)	/ANTENN/	R*4	TROCOM.INC
	Array of receiver beam boresight elevations above radio horizon in radians, ie, angle at which each antenna is aimed relative to the horizon. PSIREO(1) is the main receive antenna.		
PSITEO(NTMX)	/ANTENN/	R*4	TROCOM.INC
	Array of transmitter beam boresight elevations above radio horizon in radians, ie, angle at which each antenna is aimed relative to the horizon. PSITEO(1) is the main transmit antenna.		
S	/PATHGE/	R*4	TROCOM.INC
	Troposcatter path asymmetry parameter.		
S1	/PATHGE/	R*4	TROCOM.INC
	Troposcatter path asymmetry parameter.		
THERRF	/PATHGE/	R*4	TROCOM.INC
	Receive reference horizon in radians.		
THETAO	/PATHGE/	R*4	TROCOM.INC
	Scattering angle at bottom of common volume in radians.		
THETRF	/PATHGE/	R*4	TROCOM.INC
	Transmit reference horizon elevation in radians.		

5.22 TRLOSS

Subprogram name: Subroutine TRLOSS

Purpose: Calculates theoretical pathloss using formulas developed by S. Parl.

Reference: S. Parl, "New formulas for tropospheric scatter loss", 1979, Radio Science, Vol. 14, No. 1, pp. 42-57.

Calling sequence:
CALL TRLOSS (I1, X)

Contained in module: TRLOSS

Called by: LOOPS

Calls: ERROR

Input arguments:

I1	I*2	Receiver beam number.

Output arguments:

X	R*4	Theoretical pathloss.

Global variables input from common:

ALFAO	/PATHGE/	R*4	TROCOM.INC
	Minimum transmit antenna elevation angle measured from transmitter-to-receiver line to transmit horizon line in radians.		
BETAO	/PATHGE/	R*4	TROCOM.INC
	Minimum receive antenna elevation angle measured from receiver-to-transmitter line to receiver horizon line in radians.		
D	/PATHGE/	R*4	TROCOM.INC
	Great circle distance between transmitter and receiver measured at sea level in meters.		
DELTAR(NRMX)	/ANTENN/	R*4	TROCOM.INC
	3dB half-beamwidth of each receive antenna in radians.		
DELTAT(NTMX)	/ANTENN/	R*4	TROCOM.INC
	3dB half-beamwidth of each transmit antenna in radians.		
ICPL	/CPLOSS/	I*2	CPL.INC
	Coupling loss count.		
PSIRAO(NRMX)	/ANTENN/	R*4	TROCOM.INC
	Array of receiver beam azimuths in radians.		
PSIREO(NRMX)	/ANTENN/	R*4	TROCOM.INC
	Array of receiver beam boresight elevations above radio horizon in radians, ie, angle at which each antenna is aimed relative to the horizon. PSIREO(1)		

is the main receive antenna.

PSITEO(NTMX)	/ANTENN/	R*4	TROCOM.INC
	Array of transmitter beam boresight elevations above radio horizon in radians, ie, angle at which each antenna is aimed relative to the horizon. PSITEO(1) is the main transmit antenna.		
SCPARM	/PROPAR/	R*4	TROCOM.INC
	Wavenumber spectrum slope parameter M. Default is 3.66.		

Global variables output to common:

CPL(6)	/CPLOSS/	R*4	CPL.INC
	Aperture-to-medium coupling loss array in dB.		

CHAPTER 6

DIFFRACTION CALCULATIONS

This section describes the diffraction calculation routines:

Name	Description	User's Manual section
AVAIL	Pathloss variability	2.6.1
CONVOL	Cumulative distribution	2.6.1
DIF1	Knife-edge diffraction loss . .	2.6.2
DIFSNR	Diffraction RSL and SNR distribution	2.6.1
INTERP	Lagrangian interpolation . . .	NA
MDIF	Multiple edge diffraction loss calculations	2.6, 2.6.2-.3
TANGL	Radio horizon (take-off) angles	2.6.2, 2.6.3

The main routines for this section are DIFSNR and MDIF. Diffraction calculations are described in section 2.6 of the User's Manual.

Figure 2-3 is a top level flowchart for diffraction propagation parameter calculations at a functional level. In most cases the blocks correspond to one or more subprograms. The test blocks (diamonds) correspond to logical branches which are decided by the user's choices of input data.

NOTE

In most cases the sections in the User's Manual describe the coded equations as well as the theory behind them. NA denotes routines that are programming utilities such as finding indices, setting pointers, etc.

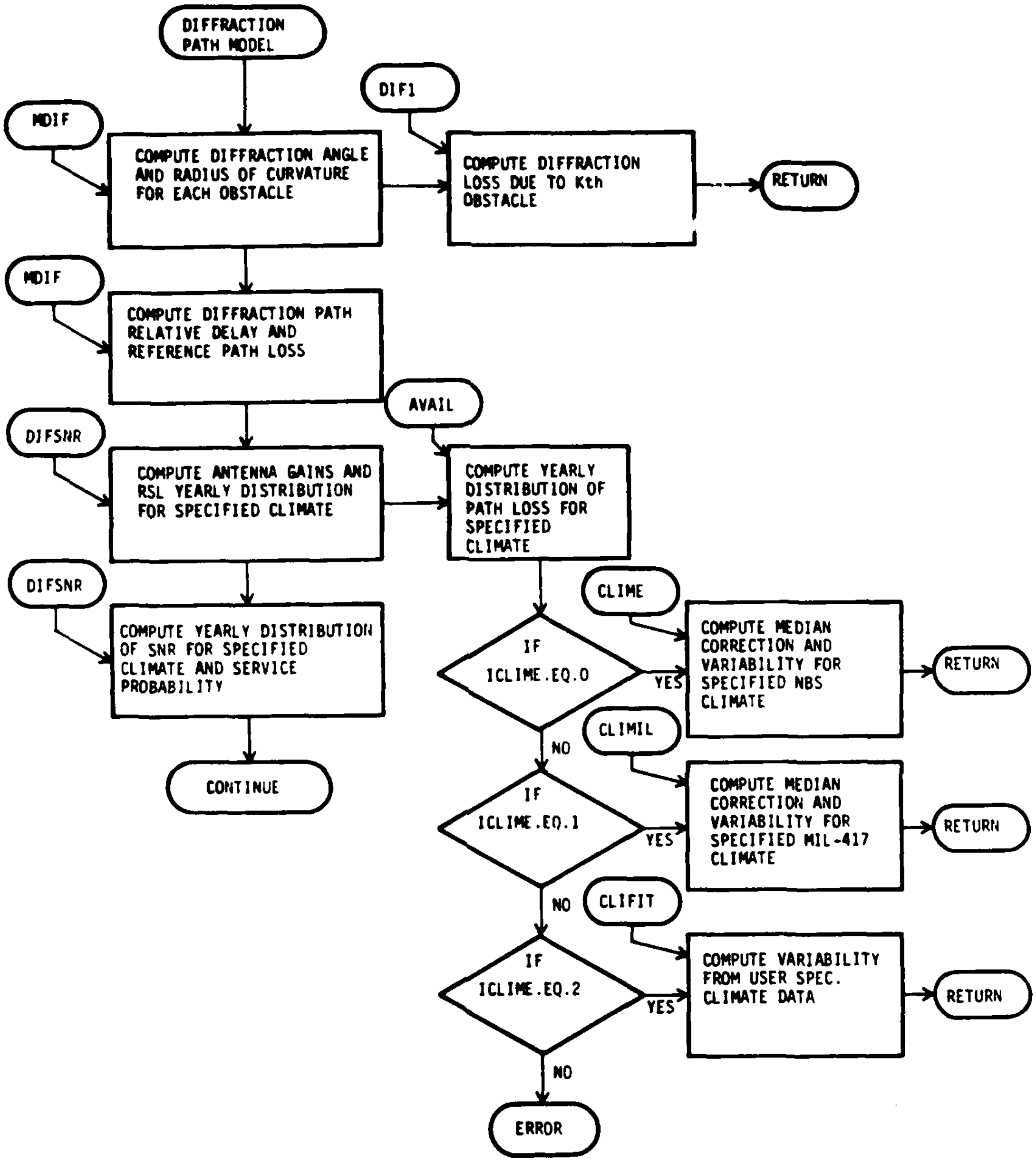


Figure 2-3 Flow Chart for Diffraction Propagation Parameter Calculations

6.1 AVAIL

Subprogram name: Subroutine AVAIL

Purpose: Routine to calculate the distribution of the pathloss variability for multiple edge diffraction paths by convolution of the pathloss variability for each section of the path, for a specified climate (KLIMAT).

Calling sequence:
CALL AVAIL (FMHZ,ND,HTE,HRE,DN,LCR,VDE,Y,QT)

Contained in module: AVAIL

Called by: DIFSNR

Calls: CLIME, CLIMIL, CLIMIX, CONVOL, INTERP

Input arguments:

FMHZ	R*4	Frequency in MHz.
ND	I*2	Number of sections in diffraction path 1<ND<6. Equal to number of edges plus one. No limit set.
HTE(ND)	R*4	Array containing transmitter (horizon) heights in meters above average terrain height for each of the ND sections in the diffraction path.
HRE(ND)	R*4	Array containing receiver (horizon) heights in meters above average terrain height for each of the ND sections in the diffraction path.
DN(ND)	R*4	Array containing great circle path length in meters of each section of path.
LCR	R*4	Long term pathloss reference value in dB

Output arguments:

VDE	R*4	Median correction factor for specified climate in dB. Set to zero when the user specifies yearly median of effective earth radius factor (SEAN = 0).
Y(11)	R*4	Array containing pathloss variability distribution about the median in dB.
QT(11)	R*4	Array containing percent of time pathloss is not exceeded, i.e. time availability

Global variables input from common:

KLIMAT /PROPAR/ I*2 TROCOM.INC
Climate zone indicator. Default is 0.
0 = User supplied climate
NBS TN101 climates
1 = Continental temperate (CT)
2 = Maritime temperate overland (MTL)
3 = Maritime temperate oversea (MTS)
4 = Maritime subtropical overland (MSL)

```
                              5 = Continental temperate time block 2 (CT2)
                                  (winter afternoon hours) - formerly
                                  Maritime subtropical oversea (MSS)
                              6 = Desert, Sahara (DS)
                              7 = Equatorial (EQU)
                              8 = Continental subtropical (CS)
                       MIL-HDBK-417 climates
                              9 = Continental temperate (CT)
                              10 = Maritime temperate overland (MTL)
                              11 = Maritime temperate oversea (MTS)
                              12 = Maritime subtropical (MS)
                              13 = Desert, Sahara (DS)
                              14 = Equatorial (EQU)
                              15 = Continental subtropical (CS)
                              16 = Mediterranean (MED)
                              17 = Polar (POL)
          LOUT         /LUNS/          I*2     LUNS.INC
                       FOR002.DAT output unit number.
          SEAN         /PROPAR/        R*4     TROCOM.INC
                       Minimum monthly median of refractivity at sea level.
                       Used to calculate ERFAC if non-zero.
```

6.2 CONVOL

Subprosram name: Subroutine CONVOL

Purpose: Routine to find the cumulative distribution function of the sum of two independent random variables siven the complementary cumulative distribution function of each of the random variables.

Callins sequence:
CALL CONVOL (FA,A,IA,FB,B,IB,FC,C,IC)

Contained in module: AVAIL

Called by: AVAIL

Calls: INTERP

Input arsuments:

FA(IA)	R*4	Array containing IA values of complementary cumulative distribution of A. Dimensioned to 50.
A(IA)	R*4	Array containing range of values of random variable A. Dimensioned to 50.
IA	I*2	Number of points in distribution A. Maximum is 50.
FB(IB)	R*4	Array containing IB values of complementary cumulative distribution of B. Dimensioned to 50.
B(IB)	R*4	Array containing range of values of random variable B. Dimensioned to 50.
IB	I*2	Number of points in distribution of B. Maximum is 50.

Output arsuments:

FC(50)	R*4	Array containing 50 values of cumulative distribution of the sum A + B.
C(50)	R*4	Array containing range of values of the sum A + B.
IC	I*2	Number of elements in cumulative distribution of A+B.

Global variables input from common:

LERR	/LUNS/	I*2	LUNS.INC
	Error output unit.		

6.3 DIF1

Subprogram name: Subroutine DIF1

Purpose: Computes the diffraction loss due to a single isolated and rounded obstacle.

Calling sequence:
CALL DIF1 (R, D1, D2, PHI, F, ATT)

Contained in module: MDIF

Called by: MDIF

Calls: NONE

Input arguments:

R	R*4	Radius of curvature of diffracting edge in meters.
D1	R*4	Distance from source (transmitter) to edge in meters.
D2	R*4	Distance from observation point (receiver) to edge in meters.
PHI	R*4	Diffraction angle in radians.
F	R*4	Frequency in MHz.

Output arguments:

ATT	R*4	Diffraction loss in dB.

Global variables input from common:

LERR	/LUNS/	I*2	LUNS.INC
	Error output unit.		
PI	/CONSTA/	R*4	CONSTANTS.INC
	Constant Pi = 3.141592654.		

6.4 DIFSNR

Subprogram name: Subroutine DIFSNR

Purpose: Routine to calculate the diffraction path loss, RSL and SNR distributions for a given service probability (SP).

Calling sequence:
CALL DIFSNR (LCR, OET, OER, BWR, ASNR, DUPOW)

Contained in module: DIFSNR

Called by: TROPO

Calls: AVAIL, AVTER, ERFC, RGAIN, TGAIN

Input arguments:

LCR	R*4	Reference value of diffraction path loss in dB.
OET	R*4	Horizon elevation angle at transmit site in radians.
OER	R*4	Horizon elevation angle at receive site in radians.
BWR	R*4	Receive antenna beamwidth in degrees.

Output arguments:

ASNR	R*4	Median and/or yearly average value of diffraction path SNR in dB.
DUPOW	R*4	Ratio of diffraction signal on upper beam to that on lower beam.

Global variables input from common:

CDEGR	/CONSTA/	R*4	CONSTANTS.INC
	Radians per degree = 0.017453293.		
D	/PATHGE/	R*4	TROCOM.INC
	Great circle distance between transmitter and receiver measured at sea level in meters.		
DL(3)	/MCOM4/	R*4	MCOM.INC
	Array containing distance from each obstacle to transmitter in meters.		
DRATE	/MCOM4/	R*4	MCOM.INC
	Data rate in bits/second. Default is 6.6E6.		
F	/SYSTRN/	R*4	TROCOM.INC
	Operating frequency in Hz. Model is accurate between 100MHz and 10GHz.		
GRDB(NRMX)	/ANTENN/	R*4	TROCOM.INC
	Gain of each receive antenna in dBi.		
GTDB(NTMX)	/ANTENN/	R*4	TROCOM.INC
	Gain of each transmit antenna in dBi.		
HI(155)	/MCOM4/	R*4	MCOM.INC
	Array containing NPM(1) evenly-spaced terrain elevation data (in meters) between transmitter and first obstacle followed by NPM(2) evenly-spaced		

terrain elevation data between first and second obstacle, etc., ending with NPM(NOBS+1) evenly-spaced terrain elevation data between last obstacle and receive site. The data should be selected such that:

HI(1) = Terrain elevation above sea level at transmit site (HTO).

HI(NPM(I)) = HI (NPM(I)+1) = Elevation of Ith obstacle above sea level (HL(I)).

HI(NPM(NOBS+1)) = Terrain elevation above sea level at receive site (HRO).

In MDTS, HI is used as work space. It is equivalenced to local arrays.

HL(3)	/MCOM4/	R*4	MCOM.INC
	Array containing elevation of each obstacle above sea level in meters. HL(1) is elevation of transmitter radio horizon HLT. HL(NOBS) is elevation of receiver radio horizon HLR.		
HLAV(3)	/MCOM4/	R*4	MCOM.INC
	Array containing average terrain elevation at each diffraction point in meters.		
HLEF(3)	/MCOM4/	R*4	MCOM.INC
	Array containing effective height of obstacles above average terrain elevation in meters.		
HRE	/MCOM4/	R*4	MCOM.INC
	Effective receiver antenna height above average terrain elevation in meters.		
HRN	/PATHGE/	R*4	TROCOM.INC
	Receive antenna height above sea level in meters.		
HTE	/MCOM4/	R*4	MCOM.INC
	Effective transmitter antenna height above average terrain elevation in meters.		
HTN	/PATHGE/	R*4	TROCOM.INC
	Transmit antenna height above sea level in meters.		
LERR	/LUNS/	I*2	LUNS.INC
	Error output unit.		
LOUT	/LUNS/	I*2	LUNS.INC
	FOR002.DAT output unit number.		
NFIG	/MCOM4/	R*4	MCOM.INC
	Receiver noise figure in dB. Default is 4dB.		
NOBS	/MCOM2/	I*2	MCOM.INC
	Number of diffraction obstacles. Maximum is 3, default is 1.		
NPM(5)	/MCOM2/	I*2	MCOM.INC
	Array containing number of terrain elevation data points for calculation of effective antenna heights for each section of the diffraction path.		
NTERR	/MCOM2/	I*2	MCOM.INC
	Control parameter for entry or calculation of effective antenna heights (HTE, HRE) and effective obstacle heights above average terrain elevation		

7.8 YINT

Subprogram name: Subroutine YINT

Purpose: Linear interpolation routine to find Y = A * DE + B.
Where: A = (Y2 - Y1) / (X2 - X1) and
B = Y1 - A * X1
For X1 < DE < X2

Calling sequence:
CALL YINT (DE,X1,X2,Y1,Y2,Y)

Contained in module: CLIME

Called by: CLIME

Calls: NONE

Input arguments:

DE	R*4	Effective distance in kilometers.
X1	R*4	Lower limit for distance interpolation in kilometers.
X2	R*4	Upper limit for distance interpolation in kilometers,
Y1	R*4	Path loss variability corresponding to X1 in dB.
Y2	R*4	Path loss variability corresponding to X2 in dB.

Output arguments:

Y	R*4	Path loss variability in dB.

7.7 VDECAL

Subprogram name: Subroutine VDECAL

Purpose: Computes the median correction factor, VDE, for the MIL-HDBK-417 climates given the C1, C2, C3, N1, N2, N3, FM, F8 constants in V(I) and the effective distance DE.

Calling sequence:
CALL VDECAL (V, DE, VDE)

Contained in module: CLIMIL

Called by: CLIMIL

Calls: NONE

Input arguments:

V(8)	R*4	Array containing the constants used in calculating VDE.
DE	R*4	Effective distance in kilometers.

Output arguments:

VDE	R*4	Median correction factor V(.5,DE) in dB according to KLIMAT.

7.6 VARPOL

Subprogram name: Function VARPOL

Purpose: Computes the value X(F), X2 < X < X1 where: F(X) is a normal distribution function with F(X1) = F1 and F(X2) = F2. The function requires that F2 < F1.

Calling sequence:
VARPOL (F,F1,F2,X1,X2,SIGMA)

Contained in module: CLIMIX

Called by: CLIMIX

Calls: NONE

Input arguments:

F	R*4	Function.
F1	R*4	Value of function F at X1.
F2	R*4	Value of function F at X2.
X1	R*4	Variability about median in dB.
X2	R*4	Variability about median in dB.
SIGMA	R*4	

Output arguments:

VARPOL	R*4	Result of interpolation between X2 and X1.

Global variables input from common:

PI	/CONSTA/	R*4	CONSTANTS.INC
	Constant Pi = 3.141592654.		

7.5 DEIND

Subprogram name: Subroutine DEIND

Purpose: Find DE indices for interpolation of climate variability data in look up tables.

Calling sequence:

```
CALL DEIND (DE,I1,I2,LIM,X1,X2,DEINC)
```

Contained in module: CLIME

Called by: CLIME

Calls: NONE

Input arguments:

DE	R*4	Effective distance in kilometers.
LIM	I*2	DE maximum increment.
DEINC	R*4	DE range increment.

Output arguments:

I1	I*2	Output index for X1 < DE < X2.
I2	I*2	Output index for X1 < DE < X2 (for DE = X1, I2 = 0).
X1	R*4	Output DE range, X1 < DE < X2, where X1 takes the values 0, DEINC, 2*DEINC, . . . , (LIM-) * DEINC.
X2	R*4	Output DE range, X1 < DE < X2.

Global variables input from common:

LERR	/LUNS/	I*2	LUNS.INC
	Error output unit.		

7.4 CLIMIX

Subprogram name: Subroutine CLIMIX

Purpose: Mixed climate variability distribution and VDE computation.

Calling sequence:
CALL CLIMIX (DE, YO, KLIM1, KLIM2, FM, VDE)

Contained in module: CLIMIX

Called by: POWER

Calls: CLIME, ERFC, VARPOL

Input arguments:

DE	R*4	Effective distance in kilometers.
KLIM1	I*2	First KLIMAT code to be mixed.
KLIM2	I*2	Second KLIMAT code to be mixed.
FM	R*4	Frequency in MHz.

Output arguments:

YO(8)	R*4	Variability distribution function YO(Q).
VDE	R*4	Time variability of basic transmission loss in dB.

Global variables input from common:

LERR	/LUNS/	I*2	LUNS.INC
	Error output unit.		
LOUT	/LUNS/	I*2	LUNS.INC
	FOR002.DAT output unit number.		

7.3 CLIMIL

Subprogram name: Subroutine CLIMIL

Purpose: Set the variability about the median, Y0 array, and the median correction factor, VDE, for MIL-HDBK-417 climates according to KLIMAT.

Calling sequence:
CALL CLIMIL (DE, Y0, KLIMAT, F, VDE)

Contained in module: CLIMIL

Called by: POWER, AVAIL

Calls: CLIFIT, VDECAL

Input arguments:

DE	R*4	Effective distance in kilometers.
KLIMAT	I*2	Climate designation.
F	R*4	Frequency in MHz.

Output arguments:

Y0(8)	R*4	Variability about median in dB.
VDE	R*4	Median correction factor V(.5,DE) in dB according to KLIMAT.

Global variables input from common:

LERR /LUNS/ I*2 LUNS.INC
Error output unit.

Global variables output to common:

DEMIN /CURVE/ R*4 CURVE.INC
User supplied minima of the 90th percentile variability curve, Y0(90).

Y900 /CURVE/ R*4 CURVE.INC
User supplied value for 90th percentile variability curve Y0(90) for DE greater than or equal 900 km. Used only when ICLIME is 2. Used to compute the equation for the Y0(90) curve fit.

YMIN /CURVE/ R*4 CURVE.INC
User supplied value for 90th percentile variability curve Y0(90) for DE equal to DEMIN. Used only when ICLIME is 2. Used to compute the equation for the Y0(90) curve fit.

7.2 CLIME

Subprogram name: Subroutine CLIME

Purpose: Calculate median correction factor VDE and path loss variability about median YO, given the effective path distance DE, NBS climate designator KLIMAT and frequency F. Set YO array and VDE according to climate code KLIMAT.

Reference: C1, C2, C3, N1, N2, N3, FM, F8 constant data for the NBS climates is from Volume II of National Bureau of Standards technical note 101: 'Transmission Loss Predictions for Tropospheric Communication Circuits', revised 1-01-67.

Calling sequence:
CALL CLIME (DE, YO, KLIMAT, F, VDE)

Contained in module: CLIME

Called by: AVAIL, CLIMIX, POWER

Calls: CLIFIT, DINT, YINT

Input arguments:

DE	R*4	Effective distance in kilometers.
KLIMAT	I*2	Climate designation.
F	R*4	Frequency in MHz.

Output arguments:

YO(8)	R*4	Variability about median in dB.
VDE	R*4	Median correction factor V(.5, DE) in dB according to climate.

Global variables input from common:

DEMIN	/CURVE/	R*4	CURVE.INC
	User supplied minima of the 90th percentile variability curve, YO(90).		
GPF	/CURVE/	R*4	CURVE.INC
	Frequency correction factor for user supplied 90th percentile variability curve. Default is 1.		
LERR	/LUNS/	I*2	LUNS.INC
	Error output unit.		

7.1 CLIFIT

Subprogram name: Subroutine CLIFIT

Purpose: Routine to fit Y0(90) curve given the value for Y0(90) for effective distance DE = 0 (YZERO), the values Y0(90) and DE for the minima of the curve (YMIN, DEMIN) and the value of Y0(90) for DE .GE. 900 km (Y900). Note: DEMIN and DE are in kilometers.

Calling sequence:

```
CALL CLIFIT (DE,Y,DC,IFLAG)
```

Contained in module: CLIME

Called by: CLIME, CLIMIL

Calls: NONE

Input arguments:

DE	R*4	Effective distance in kilometers.
DC	R*4	Cut-off distance in kilometers.
IFLAG	I*2	Flag to indicate whether variability curve coefficients are to be printed (IFLAG = 1) or not.

Output arguments:

Y	R*4	Magnitude of variability Y0(90,DE).

Global variables input from common:

DEMIN	/CURVE/	R*4	CURVE.INC
	User supplied minima of the 90th percentile variability curve, Y0(90).		
LOUT	/LUNS/	I*2	LUNS.INC
	FOR002.DAT output unit number.		
Y900	/CURVE/	R*4	CURVE.INC
	User supplied value for 90th percentile variability curve Y0(90) for DE greater than or equal 900 km. Used only when ICLIME is 2. Used to compute the equation for the Y0(90) curve fit.		
YMIN	/CURVE/	R*4	CURVE.INC
	User supplied value for 90th percentile variability curve Y0(90) for DE equal to DEMIN. Used only when ICLIME is 2. Used to compute the equation for the Y0(90) curve fit.		

CHAPTER 7

CLIMATE VARIABILITY CALCULATIONS

This section describes the climate variability calculation routines:

Name	Description	User's Manual section
CLIFIT	Climate curve fit	2.5.4.5
CLIME	Climate main routine	2.5.3.1
CLIMIL	MIL-HDBK-417 climates	2.5.3.2, 2.5.4.1, 2.5.4.2
CLIMIX	Mixed climates	2.5.3.1
DEIND	DE indices	NA
VARPOL	Interpolation	NA
VDECAL	VDE calculations	2.5.3.1
YINT	Y interpolation	NA

Climate calculations are described in sections 2.5.3 and 2.5.4 of the User's Manual.

NOTE

In most cases the sections in the User's Manual describe the coded equations as well as the theory behind them. NA denotes routines that are programming utilities such as finding indices, setting pointers, etc.

6.7 TANGL

Subprogram name: Subroutine TANGL

Purpose: Calculates radio horizon elevation angles and diffraction angle for a single diffraction path geometry.

Calling sequence:
CALL TANGL (D,HTS,HRS,DLT,DLR,HL,A,OET,OER,AHO,BHO,THETA,DO, X1,X2)

Contained in module: MDIF

Called by: MDIF

Calls: HORANG

Input arguments:

D	R*4	Great circle distance in meters.
HTS	R*4	Transmit terminal elevation above sea level in meters.
HRS	R*4	Receive terminal elevation above sea level in meters.
DLT	R*4	Great circle distance from radio horizon to transmitter (source) in meters.
DLR	R*4	Great circle distance from radio horizon to receiver (observation point) in meters.
HL	R*4	Radio horizon elevation above sea level in meters.
A	R*4	Effective earth radius in meters.

Output arguments:

OET	R*4	Radio horizon elevation angle of transmit terminal above tangent to terminal site in radians.
OER	R*4	Radio horizon elevation angle of receive terminal above tangent to terminal site in radians.
AHO	R*4	Terminal radio horizon angle above straight line intersecting both terminals in radians.
BHO	R*4	Terminal radio horizon angle above straight line intersecting both terminals in radians.
THETA	R*4	Diffraction angle in radians.
DO	R*4	Slant path range in meters.
X1	R*4	Distance from source (transmitter) to diffracting edge in meters.
X2	R*4	Distance from observation point (receiver) to diffracting edge in meters.

Global variables input from common:

LERR	/LUNS/	I*2	LUNS.INC
	Error output unit.		

Free space velocity of radio waves = 2.998E8 m/sec.

DELPB /PDATA/ R*4 PDATA.INC
Resolution of a delay cell in seconds.

LERR /LUNS/ I*2 LUNS.INC
Error output unit.

LOUT /LUNS/ I*2 LUNS.INC
FOR002.DAT output unit number.

NDELMX Parameter I*2 TROPAR.INC
Maximum number of delay bins in troposcatter power per unit delay profiles.

PI /CONSTA/ R*4 CONSTANTS.INC
Constant Pi = 3.141592654.

Global variables output to common:

DELREF /PDATA/ R*4 PDATA.INC
Minimum delay through the lowest scattering point (relative to straight line delay) in seconds.

Q(NDELMX,NCORMX) /PDATA/ R*4 PDATA.INC
Matrix of troposcatter signal power and correlation per unit delay profiles.

For DIVTYP = 0:
- Q(.,1) Power on lower beam vs. delay.
- Q(.,2) Correlation between lower and upper beam vs. delay.
- Q(.,3) Correlation between lower beams in antennas 1 & 2 vs. delay.
- Q(.,4) Power on upper beam vs. delay.
- Q(.,7) Power on diffraction path vs. delay

For DIVTYP = 1:
- Q(.,1) Power on lower beam vs. delay.
- Q(.,2) Correlation between lower and upper beam vs. delay.
- Q(.,3) Power on upper beam vs. delay
- Q(.,7) Power on diffraction path vs. delay.

For DIVTYP = 2:
- Q(.,1) Power on path 1 (lower beam) vs. delay.
- Q(.,2) Correlation between convergent paths (lower beam) vs. delay.
- Q(.,3) Correlation between divergent paths (lower beam) vs. delay.
- Q(.,4) Correlation between parallel paths (lower beam) vs. delay.
- Q(.,5) Correlation between crossing paths (lower beam) vs. delay.
- Q(.,6) Power on path of upper beam vs. delay.
- Q(.,7) Power on diffraction path vs. delay.

6.6 MDIF

Subprogram name: Subroutine MDIF

Purpose: Routine to calculate the diffraction angles, relative delay, and basic path loss of a diffraction path with multiple diffraction points.

Calling sequence:

```
CALL MDIF (KD,HL,HTN,HRN,DL,D,DS,F,A,LB,DEL,THET,THER, MODPAT,JQDM)
```

Contained in module: MDIF

Called by: TROPO

Calls: DIF1, ERROR, TANGL

Input arguments:

KD	I*2	Number of diffracting edges. No maximum set.
HL(KD)	R*4	Array containing heights above sea level of the k diffraction points in meters.
HTN	R*4	Transmit antenna height above sea level in meters.
HRN	R*4	Receive antenna height above sea level in meters.
DL(KD)	R*4	Array containing great circle distance from the transmitter to midpoint of each obstacle in meters.
D	R*4	Great circle distance between transmitter and receiver in meters.
DS(KD)	R*4	Array containing effective horizontal extent of each obstacle along great circle path in meters.
F	R*4	Carrier frequency in MHz.
A	R*4	Effective earth radius in meters.
MODPAT	I*2	Indicates whether or not to calculate modem performance. 0 = Propagation only 1 = Propagation + MD-918 modem 2 = Propagation + TRC modem
JQDM	I*2	Index in the multipath profile corresponding to the delay of the specular component.

Output arguments:

LB	R*4	Long term reference basic path loss in dB.
DEL	R*4	Diffraction path delay relative to slant range delay in seconds.
THET	R*4	Horizon elevation angle at transmit site in radians.
THER	R*4	Horizon elevation angle at receive site in radians.

Global variables input from common:

A0	/CONSTA/	R*4	CONSTANTS.INC
	Radius of the earth in meters = 6367650.		
C0	/CONSTA/	R*4	CONSTANTS.INC

6.5 INTERP

Subprogram name: Subroutine INTERP

Purpose: Routine to interpolate using nth order Lagrangian approximation.

Calling sequence:

```
CALL INTERP (IORD,IDIMX,IDIMA,FX,X,FA,A)
```

Contained in module: AVAIL

Called by: AVAIL, CONVOL

Calls: NONE

Input arguments:

IORD	I*2	Order of interpolation.
IDIMX	I*2	Dimension of input arrays. Maximum is 101.
IDIMA	I*2	Dimension of output arrays. Maximum is 50.
FX(IDIMX)	R*4	Array containing IDIMX values of dependent variable. Dimensioned to 101.
X(IDIMX)	R*4	Array containing IDIMX values of independent variable in ascending order. Dimensioned to 101.
A(IDIMA)	R*4	Array containing IDIMA values of independent variable after interpolation in ascending order. Dimensioned to 50.

Output arguments:

FA(IDIMA)	R*4	Array containing IDIMA values of dependent varaiable after interpolation. Dimensioned to 50.

```
                    (HLEF).
                            0 = HTE and HRE supplied directly
                            1 = AVETX and AVERX supplied
                            2 = HI(.) supplied
     PHDIV          /MCOM4/         R*4    MCOM.INC
                    Squint angle between upper and lower receiver beams in
                    radians.  Default is beamwidth.
     PSIREO(NRMX)   /ANTENN/        R*4    TROCOM.INC
                    Array of receiver beam boresight elevations above
                    radio horizon in radians, ie, angle at which each
                    antenna is aimed relative to the horizon.  PSIREO(1)
                    is the main receive antenna.
     PSITEO(NTMX)   /ANTENN/        R*4    TROCOM.INC
                    Array of transmitter beam boresight elevations above
                    radio horizon in radians, ie, angle at which each
                    antenna is aimed relative to the horizon.  PSITEO(1)
                    is the main transmit antenna.
     PXMIT          /MCOM4/         R*4    MCOM.INC
                    Rated transmission power in dBm.  Default is 70dBm.
     RLL            /SYSTRN/        R*4    TROCOM.INC
                    Receiver line losses in dB.  Default is 0 dB.
     SP             /MCOM4/         R*4    MCOM.INC
                    Service probability.  Default is .95.
     THER           /PATHGE/        R*4    TROCOM.INC
                    Radio horizon elevation angle at receive site in
                    radians.
     THET           /PATHGE/        R*4    TROCOM.INC
                    Radio horizon elevation angle at transmit site in
                    radians.
     TLL            /SYSTRN/        R*4    TROCOM.INC
                    Transmitter line losses in dB.  Default is 0 dB.

  Global variables output to common:
     AVERX          /MCOM4/         R*4    MCOM.INC
                    Average terrain elevation above sea level between
                    receive site and radio horizon, in meters.
     AVETX          /MCOM4/         R*4    MCOM.INC
                    Average terrain elevation above sea level between
                    transmit site and radio horizon, in meters.
     DIFLOS(3)      /SUMP/          R*4    CURVE.INC
                    Median diffraction path loss in dB for each value in
                    ERFAC distribution.
     DIFRSL(3)      /SUMP/          R*4    CURVE.INC
                    Median diffraction signal RSL in dBm for each value in
                    ERFAC distribution.
     DSTSNR         /SUMP/          R*4    CURVE.INC
                    Standard deviation of diffracted signal long-term SNR
                    distribution in dB.
```

CHAPTER 8

BUTTERWORTH FILTER CALCULATIONS

This section describes the Butterworth filter calculation routines:

Name	Description	User's Manual section
A50FCC	FCC filter attenuation relative to 50dB	2.7
BUTFIL	Main filter routine	2.7
BWJAM	Interference power spectrum . .	2.7.3
ENRGF	Energy of filter cascade . . .	2.7
FCCMSK	FCC 19311 mask compare	NA
FFT	Fast Fourier transform	NA
FUNBW	Bandwidth constraint test . . .	NA
FUNJAM	Degradation test	NA
INTERB	Linear interpolation	NA
PEAK	Impulse response peak	NA
PSPEC	Power spectrum - Butterworth .	2.7
PSPEC1	Power spectrum - receiver . . .	2.7
PSPEC2	Power spectrum - interferer-receiver	2.7.3
PSPJ	Power spectrum - interferer . .	2.7.3
RTMI	Newton's iteration for non-linear equations	NA
SAMPLE	Impulse response	NA
SEARCH	Filter specification	NA
SPEC	Spectrum - Butterworth	2.7
SPEC1	Spectrum - receiver	2.7
SPEC2	Spectrum - transmitter	2.7.3

The main routine for this section is BUTFIL. These calculations are described in section 2.7 of the User's Manual.

Figure 2-4 is a top level flowchart for filter and interference effects calculations at a functional level. In most cases the blocks correspond to one or more subprograms. The test blocks (diamonds) correspond to logical branches which are decided by the user's choices of input data.

NOTE

In most cases the sections in the User's Manual describe the coded equations as well as the theory behind them. NA denotes routines that are programming utilities such as finding indices, setting pointers, etc.

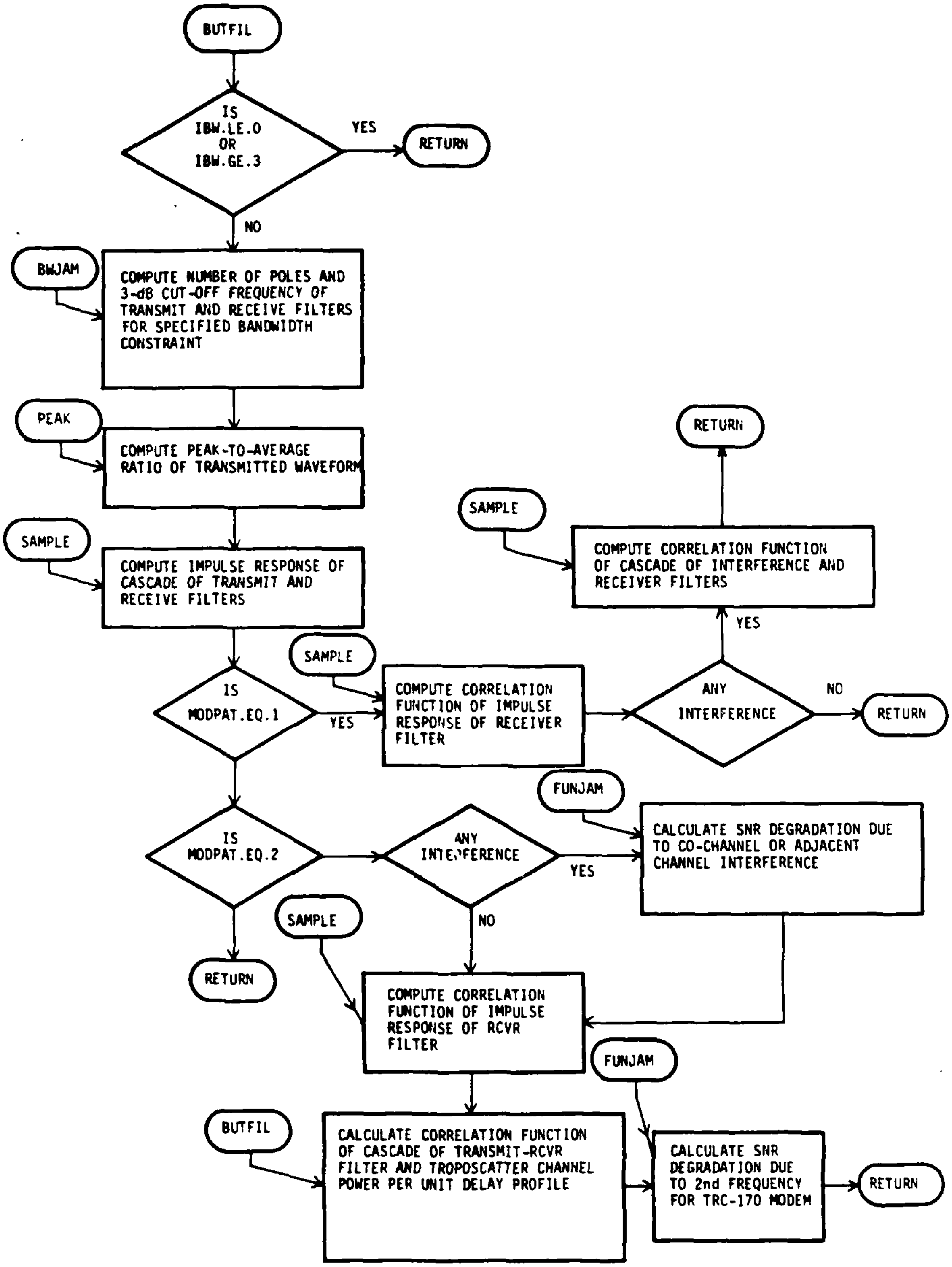


Figure 2-4 Flow Chart for Filter and Interference Effects Calculations

8.1 A50FCC

Subprogram name: Function A50FCC

Purpose: Calculates filter attenuation at normalized frequency F relative to 50dB attenuation.

Calling sequence:
A50FCC (F)

Contained in module: BUTFIL

Called by: FCCMSK, FUNBW

Calls: PSPEC

Input arguments:

F R*4 Frequency relative to the center of the band normalized to the symbol rate.

Output arguments:

A50FCC R*4 Filter attenuation at normalized frequency F relative to 50dB attenuation.

Global variables input from common:

FCTX /BUTPAR/ R*4 BUTPAR.INC
Normalized 3dB cut-off frequency of transmitter filter.

IFILTX /BUTPAR/ I*2 BUTPAR.INC
Transmitter filter indicator.
0 = MD-918 transmitter filter. Also means filter is a Butterworth cascaded with a rectangular impulse response filter of duration equal to symbol duration.
1 = AN/TRC-170 transmitter filter. Also means filter is a cascade of Butterworth filter with rectangular impulse response filter of duration equal to half symbol duration.
2 = (not allowed)

NPOLTX /BUTPAR/ I*2 BUTPAR.INC
Number of poles in the transmit Butterworth filter.

PENERG /BUTPAR/ R*4 BUTPAR.INC
Normalized energy of filter.

RSDB /BUTPAR/ R*4 BUTPAR.INC
10 times the base 10 logarithm of the symbol rate minus 60.

8.2 BUTFIL

Subprogram name: Subroutine BUTFIL

Purpose: Calculate filter related parameters for MD-918 and TRC-170 modems.

Calling sequence:

```
CALL BUTFIL (DRATE,BW,IBW,TAPW,TAU22,JPOW1,JBW1,
FJSEP,MODSI1,MODPAT,TRCTYP)
```

Contained in module: BUTFIL

Called by: TROPO

Calls: BWJAM, FUNJAM, PEAK, PSPEC1, PSPEC2, SAMPLE, SPEC1, SPEC2

Input arguments:

```
DRATE   R*4   Data rate in bits/second.
BW      R*4   Signal bandwidth in Hertz.
IBW     I*2   RF bandwidth filtering constraint indicator:
                      0 = no constraint
                      1 = 99% bandwidth constraint
                      2 = FCC 19311 mask
                      3 = user supplied
TAPW    R*4   MD-918 AFE normalized tap spacing.
TAU22   R*8   RMS delay spread of troposcatter signal in lower beam
              in nanoseconds.
JPOW1   R*8   Interfering signal power density in dBm/Hz.
JBW1    R*8   Interfering signal bandwidth in Hertz.
FJSEP   R*4   Frequency separation between desired signal and
              interference signal in Hertz.
MODSI1  I*2   Interference modulation type indicator:
                      0 = FDM/FM
                      1 = QPSK
MODPAT  I*2   Indicates whether or not to calculate modem
              performance.
                      0 = Propagation only
                      1 = Propagation + MD-918 modem
                      2 = Propagation + TRC modem
                      3 = Propagation + user supplied modem
TRCTYP  R*4   AN/TRC-170 modem type indicator:
                      0 = 1 frequency DAR modem
                      1 = 2 frequency AN/TRC-170
```

Output arguments:

```
BW      R*4   99% bandwidth of transmit filter specified by user
              (IBW = 3) in Hertz.
```

Global variables input from common:

```
LERR            /LUNS/          I*2     LUNS.INC
                Error output unit.
LOUT            /LUNS/          I*2     LUNS.INC
                FOR002.DAT output unit number.
NPOLRX          /BUTPAR/        R*4     BUTPAR.INC
                Number of poles in the receive Butterworth filter.
NPOLTX          /BUTPAR/        I*2     BUTPAR.INC
                Number of poles in the transmit Butterworth filter.
NTR             /RZ4/           I*2     RZ4.INC
                Number of samples for calculating transmit-receive
                filter impulse response (TRFILT).
PENERG          /BUTPAR/        R*4     BUTPAR.INC
                Normalized energy of filter.
PI              /CONSTA/        R*4     CONSTANTS.INC
                Constant Pi = 3.141592654.
PJ              /JAMPAR/        R*4     JAMPAR.INC
                Normalization constant for interference calculations.
RCOR(32)        /RZ4/           R*4     RZ4.INC
                Correlation function of the receive filter in steps
                equal to the tapwidth (TAPW) for MD-918 modem, or
                equal to 1/RATE for AN/TRC-170 or DAR modem.

Global variables output to common:
CONJAM          /JAMPAR/        R*4     JAMPAR.INC
                Interference constant.
FCON            /BUTPAR/        R*4     BUTPAR.INC
                Ratio of bandwidth to twice the symbol rate.
FCRX            /BUTPAR/        R*4     BUTPAR.INC
                Normalized 3dB cut-off frequency of receiver filter.
FCTX            /BUTPAR/        R*4     BUTPAR.INC
                Normalized 3dB cut-off frequency of transmitter
                filter.
FJSEPN          /JAMPAR/        R*4     JAMPAR.INC
                Normalized frequency separation between the
                interference signal and the desired signal.
ICON            /BUTPAR/        I*2     BUTPAR.INC
                   1 = 99% bandwidth constraint
                   2 = FCC-13911 bandwidth constraint
IFILRX          /BUTPAR/        I*2     BUTPAR.INC
                Receiver filter indicator.
                        0 = MD-918 receiver filter.  Also means
                            filter is a Butterworth cascaded with a
                            rectangular impulse response filter of
                            duration equal to symbol duration.
                        1 = (not allowed)
                        2 = AN/TRC-170 receiver filter.  Also means
                            filter is a Butterworth.
IFILTX          /BUTPAR/        I*2     BUTPAR.INC
                Transmitter filter indicator.
                        0 = MD-918 transmitter filter.  Also means
```

filter is a Butterworth cascaded with a rectansular impulse response filter of duration equal to symbol duration.
1 = AN/TRC-170 transmitter filter. Also means filter is a cascade of Butterworth filter with rectansular impulse response filter of duration equal to half symbol duration.
2 = (not allowed)

JBW /JAMPAR/ R*4 JAMPAR.INC
99% interferer bandwidth in MHz.

JPOW /JAMPAR/ R*4 JAMPAR.INC
Interferer power density in dBm/Hz: -174 or less denotes no interference. Default is -1000 dBm/Hz.

MODSG /JAMPAR/ I*2 JAMPAR.INC
Interference sisnal modulation format. Default is 1.
0 = Analos FDM / FM
1 = Disital QPSK

NJR /RZ4/ I*2 RZ4.INC
Number of sample points for RJCOR.

PEAKAV /RZ4/ R*4 RZ4.INC
Peak-to-averase loss due to RF filtering in dB.

RJCOR(129) /RZ4/ R*4 RZ4.INC
Correlation function of interferer-receiver filters at RATE points per symbol interval.

RSDB /BUTPAR/ R*4 BUTPAR.INC
10 times the base 10 logarithm of the symbol rate minus 60.

SNRBW /RZ4/ R*4 RZ4.INC
Signal to noise ratio adjustment for AN/TRC-170 due to limited receive filter bandwidth.

SNRF2 /RZ4/ R*4 RZ4.INC
Parameter to adjust the signal to noise ratio for desradation due to interference from another frequency. Only for 2-frequency AN/TRC-170 modem.

SNRJAM /RZ4/ R*4 RZ4.INC
Parameter to adjust the signal to noise ratio of AN/TRC-170 for desradation due to colocated/adjacent channel interference.

TRFILT(128) /RZ4/ R*4 RZ4.INC
Transmit-receive filter impulse response.

XTRO /RZ4/ R*4 RZ4.INC
Time origin for transmit-receive filter impulse response (TRFILT), ie, X is TRFILT(X+XTRO).

XTRINC /RZ4/ R*4 RZ4.INC
Sample interval for calculation of transmit-receive filter impulse response (TRFILT).

8.3 BWJAM

Subprogram name: Subroutine BWJAM

Purpose: Specify power spectrum for interference and calculate transmit filter and receive filter parameters. Calculate number of poles and 3dB cut-off frequency of transmit and receive filters for specified bandwidth constraint.

Calling sequence:

```
CALL BWJAM (MODPAT,TRCTYP,FLOWER,FUPPER,NLOWER,NUPPER, IBW,BW,SRATE)
```

Contained in module: BUTFIL

Called by: BUTFIL

Calls: ENRGF, FUNBW, FUNJAM, RTMI, SEARCH

Input arguments:

MODPAT	I*2	Indicates whether or not to calculate modem performance. 0 = Propagation only 1 = Propagation + MD-918 modem 2 = Propagation + TRC modem 3 = Propagation + user supplied modem
TRCTYP	R*4	AN/TRC-170 modem type indicator: 0 = 1 frequency DAR modem 1 = 2 frequency AN/TRC-170
FLOWER	R*4	Smallest normalized cut-off frequency of interest for Butterworth filter.
FUPPER	R*4	Largest normalized cut-off frequency of interest for Butterworth filter.
NLOWER	I*2	Smallest number of poles of interest for Butterworth filter.
NUPPER	I*2	Largest number of poles of interest for Butterworth filter.
IBW	I*2	RF bandwidth filtering constraint indicator: 0 = no constraint 1 = 99% bandwidth constraint 2 = FCC 19311 mask 3 = user supplied
BW	R*4	Signal bandwidth in Hertz.
SRATE	R*4	Symbol rate in symbols/second.

Output arguments:

Global variables input from common:

FCTX	/BUTPAR/	R*4	BUTPAR.INC
	Normalized 3dB cut-off frequency of transmitter filter.		

```
IFILTX        /BUTPAR/       I*2    BUTPAR.INC
              Transmitter filter indicator.
                     0 = MD-918 transmitter filter.  Also means
                         filter is a Butterworth cascaded with a
                         rectangular impulse response filter of
                         duration equal to symbol duration.
                     1 = AN/TRC-170 transmitter filter.  Also means
                         filter is a cascade of Butterworth filter
                         with rectangular impulse response filter
                         of duration equal to half symbol duration.
                     2 = (not allowed)
JBW           /JAMPAR/       R*4    JAMPAR.INC
              99% interferer bandwidth in MHz.
JPOW          /JAMPAR/       R*4    JAMPAR.INC
              Interferer power density in dBm/Hz; -174 or less
              denotes no interference.  Default is -1000 dBm/Hz.
LERR          /LUNS/         I*2    LUNS.INC
              Error output unit.
MODSG         /JAMPAR/       I*2    JAMPAR.INC
              Interference signal modulation format.  Default is 1.
                     0 = Analog FDM / FM
                     1 = Digital QPSK
PENERG        /BUTPAR/       R*4    BUTPAR.INC
              Normalized energy of filter.

Global variables output to common:
CONJAM        /JAMPAR/       R*4    JAMPAR.INC
              Interference constant.
FCJ           /JAMPAR/       R*4    JAMPAR.INC
              Normalized 3dB cut-off frequency of QPSK interference
              filter.
FCON          /BUTPAR/       R*4    BUTPAR.INC
              Ratio of bandwidth to twice the symbol rate.
FCRX          /BUTPAR/       R*4    BUTPAR.INC
              Normalized 3dB cut-off frequency of receiver filter.
FMI           /JAMPAR/       R*4    JAMPAR.INC
              Modulation index for FDM/FM interference.
ICON          /BUTPAR/       I*2    BUTPAR.INC
                 1 = 99% bandwidth constraint
                 2 = FCC-13911 bandwidth constraint
NPOLJ         /JAMPAR/       I*2    JAMPAR.INC
              Number of poles in the QPSK interference filter.
NPOLRX        /BUTPAR/       R*4    BUTPAR.INC
              Number of poles in the receive Butterworth filter.
NPOLTX        /BUTPAR/       I*2    BUTPAR.INC
              Number of poles in the transmit Butterworth filter.
PJ            /JAMPAR/       R*4    JAMPAR.INC
              Normalization constant for interference calculations.
WFM           /JAMPAR/       R*4    JAMPAR.INC
              Normalization constant for FDM/FM interference.
```

8.4 ENRGF

Subprogram name: Subroutine ENRGF

Purpose: To calculate 'energy' of cascade of Butterworth filter and filter with rectangular impulse response by integrating power spectrum of the cascade of the two filters.

Calling sequence:
CALL ENRGF (NPOLE,FCUT,IFILT,PENERG,FINCR,IERR)

Contained in module: BUTFIL

Called by: BWJAM, FUNBW, FUNJAM

Calls: PSPEC

Input arguments:

NPOLE	I*2	Number of poles of Butterworth filter.
FCUT	R*4	Normalized 3-dB cut off frequency of Butterworth filter.
IFILT	I*2	Rectangular impulse response filter duration flag: 0 = symbol duration 1 = half-symbol duration 2 = no rectangular impulse response filter
FINCR	R*4	Normalized frequency increment for integration.

Output arguments:

PENERG	R*4	Energy of cascade of the two filters.
IERR	I*2	Error flag: 0 = no error; 1 = integral did not converge.

8.5 FCCMSK

Subprogram name: Subroutine FCCMSK

Purpose: To compare filter attenuation as a function of frequency with FCC 19311 mask.

Calling sequence:
CALL FCCMSK (N1,N2,N3,IERR)

Contained in module: BUTFIL

Called by: FUNBW

Calls: A50FCC

Input arguments:

N1	I*2	Number of frequencies to be tested in flat 50 dB region.
N2	I*2	Number of frequencies to be tested in linear attenuation region.
N3	I*2	Number of frequencies to be tested in flat 80 dB region.

Output arguments:

IERR	I*2	Error flag.

Global variables input from common:

F50L	/BUTPAR/	R*4	BUTPAR.INC
	50dB normalized corner frequency.		
RSDB	/BUTPAR/	R*4	BUTPAR.INC
	10 times the base 10 logarithm of the symbol rate minus 60.		

8.6 FFT

Subprogram name: Subroutine FFT

Purpose: Fast Fourier transform.

Reference: Oppenheim, Shaffer, Digital Signal Processing, p.332.

Calling sequence:

```
CALL FFT (X,M,INDEX)
```

Contained in module: BUTFIL

Called by: SAMPLE

Calls: NONE

Input arguments:

X(128)	C*8	Input sequence.
M	I*2	Log base 2 of number of points in the transform.
INDEX	I*2	Processing switch: 1 = Direct FFT -1 = Inverse FFT

Output arguments:

X(128)	C*8	Output (fourier transformed) sequence.

Global variables input from common:

PI	/CONSTA/	R*4	CONSTANTS.INC
	Constant Pi = 3.141592654.		

8.7 FUNBW

Subprogram name: Function FUNBW

Purpose: To determine whether Butterworth filter with normalized cut-off frequency FC meets 99% or FCC 19311 bandwidth constraint (FUNBW < 0) or not.

Calling sequence:
FUNBW (FC)

Contained in module: BUTFIL

Called by: BUTFIL, BWJAM

Calls: A50FCC, ENRGF, FCCMSK, INTERB, PSPEC

Input arguments:

FC	R*4	Normalized cut-off frequency of Butterworth filter.

Output arguments:

FUNBW	R*4	Flags whether Butterworth filter with normalized cut-off frequency FC meets 99% or FCC 19311 bandwidth constraint (FUNBW < 0) or not.

Global variables input from common:

```
FCON        /BUTPAR/      R*4    BUTPAR.INC
            Ratio of bandwidth to twice the symbol rate.
ICON        /BUTPAR/      I*2    BUTPAR.INC
               1 = 99% bandwidth constraint
               2 = FCC-13911 bandwidth constraint
IFILTX      /BUTPAR/      I*2    BUTPAR.INC
            Transmitter filter indicator.
                   0 = MD-918 transmitter filter.  Also means
                       filter is a Butterworth cascaded with a
                       rectangular impulse response filter of
                       duration equal to symbol duration.
                   1 = AN/TRC-170 transmitter filter.  Also means
                       filter is a cascade of Butterworth filter
                       with rectangular impulse response filter
                       of duration equal to half symbol duration.
                   2 = (not allowed)
NPOLTX      /BUTPAR/      I*2    BUTPAR.INC
            Number of poles in the transmit Butterworth filter.
PENERG      /BUTPAR/      R*4    BUTPAR.INC
            Normalized energy of filter.
```

Global variables output to common:

```
F50L        /BUTPAR/      R*4    BUTPAR.INC
            50dB normalized corner frequency.
```

8.18 SPEC

Subprogram name: C*8 Function SPEC

Purpose: Evaluate the spectrum (Fourier transform of impulse response) at normalized frequency F of the cascade of a Butterworth filter and a filter with a rectangular impulse response.

Calling sequence:
SPEC (F,NPOLE,FCUT,IFILT)

Contained in module: BUTFIL

Called by: SPEC1, SPEC2

Calls: NONE

Input arguments:

F	R*4	Frequency relative to the center of the band normalized to the symbol rate.
NPOLE	I*2	Number of poles of Butterworth filter.
FCUT	R*4	Normalized 3dB cutoff frequency of Butterworth filter.
IFILT	I*2	Rectangular impulse response filter duration flag: 0 = symbol duration 1 = half-symbol duration 2 = response of filter is an impulse

Output arguments:

SPEC	C*8	Spectrum (Fourier transform of impulse response) at normalized frequency F of the cascade of a Butterworth filter and a filter with a rectangular impulse response.

Global variables input from common:

PI	/CONSTA/	R*4	CONSTANTS.INC
	Constant Pi = 3.141592654.		

8.17 SEARCH

Subprogram name: Subroutine SEARCH

Purpose: Specify a Butterworth filter with NPOLE poles, where NLOWER < NPOLE < NUPPER and 3dB cut-off frequency FCUT is FLOWER < FCUT < FUPPER to satisfy the constraint FUN < 0 and to mimimize a pulse duration criterion.

Calling sequence:

```
CALL SEARCH (IFUN,FUN,FLOWER,FUPPER,NLOWER,NUPPER,FCUT, NPOLE,IERR)
```

Contained in module: BUTFIL

Called by: BWJAM

Calls: RTMI FUNJAM FUNBW

Input arguments:

```
     IFUN     I*2     Process switch:
                         1 = specify transmit filter parameters
                         2 = specify receive filter parameters
     FLOWER   R*4     Lower limit for cut-off frequency, FCUT.
     FUPPER   R*4     Upper limit for cut-off frequency, FCUT.
     NLOWER   I*2     Lower limit for number of poles, NPOLE.
     NUPPER   I*2     Upper limit for number of poles, NPOLE.
     FUN      R*4     Function name:
                         For IFUN = 1, FUN = FUNBW
                         For IFUN = 2, FUN = FUNJAM
```

Output arguments:

```
     FCUT     R*4     3-dB cut off frequency of Butterworth filter.
     NPOLE    I*2     Number of poles of Butterworth filter.
     IERR     I*2     Error flag:
                                0 = no error
                                1 = FLOWER is too large
                                2 = FUPPER is too small
                                3 = no solution found
```

Global variables input from common:

```
     LERR             /LUNS/          I*2     LUNS.INC
                      Error output unit.
     PI               /CONSTA/        R*4     CONSTANTS.INC
                      Constant Pi = 3.141592654.
```

Global variables output to common:

```
     NPOLRX           /BUTPAR/        R*4     BUTPAR.INC
                      Number of poles in the receive Butterworth filter.
     NPOLTX           /BUTPAR/        I*2     BUTPAR.INC
                      Number of poles in the transmit Butterworth filter.
```

8.16 SAMPLE

Subprogram name: Subroutine SAMPLE

Purpose: Calculate impulse response of filter with spectrum (Fourier Transform of impulse response) WFUN.

Calling sequence:

```
CALL SAMPLE (WSAMPL,WFUN,RATE,MMIN,MMAX,TMAX,FMAX,NSMPL,IERR)
```

Contained in module: BUTFIL

Called by: BUTFIL

Calls: FFT

Input arguments:

RATE	R*4	Sampling rate in samples/unit of time.
MMIN	I*2	Log base 2 of minimum FFT length to be considered.
MMAX	I*2	Log base 2 of maximum FFT length to be considered.
TMAX	R*4	Maximum length of impulse response.
FMAX	R*4	Maximum frequency in spectrum.

Output arguments:

WSAMPL(128)	R*4	Impulse response.
WFUN	C*8	Spectrum function name.
NSMPL	I*2	Number of samples in impulse response.
IERR	I*2	Error flag: 0 = no error; 1 = inadequate FFT length.

8.15 RTMI

Subprogram name: Subroutine RTMI

Purpose: IBM SSP Library routine. RTMI solves the general nonlinear equation of the form FCN(x) = 0 by Newton's iteration method.

Calling sequence:

```
CALL RTMI (X,F,FCT,XLI,XRI,EPS,IEND,IER)
```

Contained in module: BUTFIL

Called by: BWJAM, SEARCH

Calls: NONE

Input arguments:

FCT	R*4	Name of external subroutine used. It computes to given argument X and function value F. Parameter list must be X, F.
XLI	R*4	Smallest value of X.
XRI	R*4	Largest value of X.
EPS	R*4	Input value that specifies the upper bound of the error of result X.
IEND	I*2	Maximum number of iteration steps specified.

Output arguments:

X	R*4	Resultant root of equation f(x) = 0.
F	R*4	Resultant function value at root X.
IER	I*2	Resultant error code: 0 = No error. 1 = No convergence after IEND iteration steps.

PI	/CONSTA/	R*4	CONSTANTS.INC
	Constant Pi = 3.141592654.		
WFM	/JAMPAR/	R*4	JAMPAR.INC
	Normalization constant for FDM/FM interference.		

8.14 PSPJ

Subprogram name: Function PSPJ

Purpose: Power spectrum of interferer at frequency F.

Calling sequence:
PSPJ (F)

Contained in module: BUTFIL

Called by: FUNJAM, PSPEC2, PWRSPC

Calls: PSPEC

Input arguments:

F	R*4	Frequency relative to the center of the band normalized to the symbol rate.

Output arguments:

PSPJ	R*4	Power spectrum of interferer at frequency F.

Global variables input from common:

FCJ /JAMPAR/ R*4 JAMPAR.INC
Normalized 3dB cut-off frequency of QPSK interference filter.

FCTX /BUTPAR/ R*4 BUTPAR.INC
Normalized 3dB cut-off frequency of transmitter filter.

FMI /JAMPAR/ R*4 JAMPAR.INC
Modulation index for FDM/FM interference.

IFILTX /BUTPAR/ I*2 BUTPAR.INC
Transmitter filter indicator.
- 0 = MD-918 transmitter filter. Also means filter is a Butterworth cascaded with a rectangular impulse response filter of duration equal to symbol duration.
- 1 = AN/TRC-170 transmitter filter. Also means filter is a cascade of Butterworth filter with rectangular impulse response filter of duration equal to half symbol duration.
- 2 = (not allowed)

MODSG /JAMPAR/ I*2 JAMPAR.INC
Interference signal modulation format. Default is 1.
- 0 = Analog FDM / FM
- 1 = Digital QPSK

NPOLJ /JAMPAR/ I*2 JAMPAR.INC
Number of poles in the QPSK interference filter.

NPOLTX /BUTPAR/ I*2 BUTPAR.INC
Number of poles in the transmit Butterworth filter.

8.13 PSPEC2

Subprogram name: C*8 Function PSPEC2

Purpose: To calculate power spectrum of interferer-receiver filters at normalized frequency F.

Calling sequence:
PSPEC2 (F)

Contained in module: BUTFIL

Called by: BUTFIL

Calls: PSPEC, PSPJ

Input arguments:

F	R*4	Frequency relative to the center of the band normalized to the symbol rate.

Output arguments:

PSPEC2	C*8	Power spectrum of interferer-receiver filters at normalized frequency F.

Global variables input from common:

FCRX /BUTPAR/ R*4 BUTPAR.INC
Normalized 3dB cut-off frequency of receiver filter.

FJSEPN /JAMPAR/ R*4 JAMPAR.INC
Normalized frequency separation between the interference signal and the desired signal.

IFILRX /BUTPAR/ I*2 BUTPAR.INC
Receiver filter indicator.
- 0 = MD-918 receiver filter. Also means filter is a Butterworth cascaded with a rectangular impulse response filter of duration equal to symbol duration.
- 1 = (not allowed)
- 2 = AN/TRC-170 receiver filter. Also means filter is a Butterworth.

NPOLRX /BUTPAR/ R*4 BUTPAR.INC
Number of poles in the receive Butterworth filter.

8.12 PSPEC1

Subprogram name: C*8 Function PSPEC1

Purpose: To calculate power spectrum of receiver filter at normalized frequency F.

Calling sequence:
PSPEC1 (F)

Contained in module: BUTFIL

Called by: BUTFIL

Calls: PSPEC

Input arguments:

F	R*4	Frequency relative to the center of the band normalized to the symbol rate.

Output arguments:

PSPEC1	C*8	Power spectrum of receiver filter at normalized frequency F.

Global variables input from common:

FCRX /BUTPAR/ R*4 BUTPAR.INC
Normalized 3dB cut-off frequency of receiver filter.

IFILRX /BUTPAR/ I*2 BUTPAR.INC
Receiver filter indicator.
0 = MD-918 receiver filter. Also means filter is a Butterworth cascaded with a rectangular impulse response filter of duration equal to symbol duration.
1 = (not allowed)
2 = AN/TRC-170 receiver filter. Also means filter is a Butterworth.

NPOLRX /BUTPAR/ R*4 BUTPAR.INC
Number of poles in the receive Butterworth filter.

8.11 PSPEC

Subprogram name: Function PSPEC

Purpose: To calculate power spectrum of cascade of Butterworth filter with rectangular impulse response filter at normalized frequency F.

Calling sequence:
PSPEC (F,NPOLE,FCUT,IFILT)

Contained in module: BUTFIL

Called by: A50FCC, ENRGF, FUNBW, FUNJAM, PSPEC1, PSPEC2, PSPJ, PWRSPC

Calls: NONE

Input arguments:

F	R*4	Frequency relative to the center of the band normalized to the symbol rate.
NPOLE	I*2	Number of poles of Butterworth filter.
FCUT	R*4	Normalized 3-dB cut off frequency of Butterworth filter.
IFILT	I*2	Rectangular impulse response filter duration flag: 0 = symbol duration 1 = half-symbol duration 2 = impulse response is an impulse.

Output arguments:

PSPEC	R*4	Power spectrum of cascade of Butterworth filter with rectangular impulse response filter at normalized frequency F.

Global variables input from common:

PI	/CONSTA/	R*4	CONSTANTS.INC
	Constant Pi = 3.141592654.		

8.10 PEAK

Subprogram name: Subroutine PEAK

Purpose: To calculate the peak of the transmitted waveform impulse response.

Calling sequence:

```
CALL PEAK (XMAX,IMAX,X,N)
```

Contained in module: BUTFIL

Called by: BUTFIL

Calls: NONE

Input arguments:

X(N)	R*4	Impulse response of transmitted waveform. Dimensioned to 128.
N	I*2	Number of samples in impulse response. Maximum is 128.

Output arguments:

XMAX	R*4	Peak value of impulse response.
IMAX	I*2	Index of peak sample.

8.9 INTERB

Subprogram name: Subroutine INTERB

Purpose: Linear interpolation in a table of N pairs (XX,YY).

Calling sequence:
    CALL INTERB (Y,X,YY,XX,N,IERR)

Contained in module: BUTFIL

Called by: FUNBW

Calls: NONE

Input arguments:

X	R*4	Value of x-coordinate for which y-coordinate is desired.
YY(N)	R*4	Tabulated values of y-coordinate corresponding to tabulated x-coordinate. Dimensioned to 30.
XX(N)	R*4	Tabulated value of x-coordinate in decreasing order. Dimensioned to 30.
N	I*2	Number of tabulated values over which interpolation is to be performed. Maximum is 30.

Output arguments:

Y	R*4	Value of y-coordinate corresponding to x-coordinate.
IERR	I*2	Error flag: 0 = no error 5 = x-coordinate value greater than largest tabulated value 6 = x-coordinate value less than smallest tabulated value

8.8 FUNJAM

Subprogram name: Function FUNJAM

Purpose: To determine whether adjacent channel interference power within receiver bandwidth, calculated by integrating over the product of the interference power spectrum and the receiver filter power spectrum, degrades the SNL by less than 1 dB.

Calling sequence:
FUNJAM (FC)

Contained in module: BUTFIL

Called by: BUTFIL, BWJAM

Calls: ENRGF, PSPEC, PSPJ

Input arguments:
FC R*4 Normalized cut-off frequency of Butterworth filter.

Output arguments:
FUNJAM R*4 Flags whether adjacent channel interference power within receiver bandwidth degrades the SNL by less than 1 dB.

Global variables input from common:

CONJAM /JAMPAR/ R*4 JAMPAR.INC
Interference constant.

FJSEPN /JAMPAR/ R*4 JAMPAR.INC
Normalized frequency separation between the interference signal and the desired signal.

IFILRX /BUTPAR/ I*2 BUTPAR.INC
Receiver filter indicator.
- 0 = MD-918 receiver filter. Also means filter is a Butterworth cascaded with a rectangular impulse response filter of duration equal to symbol duration.
- 1 = (not allowed)
- 2 = AN/TRC-170 receiver filter. Also means filter is a Butterworth.

NPOLRX /BUTPAR/ R*4 BUTPAR.INC
Number of poles in the receive Butterworth filter.

PJ /JAMPAR/ R*4 JAMPAR.INC
Normalization constant for interference calculations.

FCTX	/BUTPAR/	R*4	BUTPAR.INC
	Normalized 3dB cut-off frequency of transmitter filter.		

8.19 SPEC1

```
Subprogram name:     C*8 Function SPEC1

Purpose:     Evaluate the spectrum (Fourier transform of impulse response)
     at normalized frequency F of the receiver filter.

Calling sequence:
     SPEC1 (F)

Contained in module: BUTFIL

Called by:   BUTFIL

Calls:       SPEC

Input arguments:
     F       R*4     Frequency relative to the center of the band
                     normalized to the symbol rate.

Output arguments:
     SPEC1   C*8     Spectrum (Fourier transform of impulse response)
                     at normalized frequency F of the receiver filter.

Global variables input from common:
     FCRX            /BUTPAR/        R*4     BUTPAR.INC
                     Normalized 3dB cut-off frequency of receiver filter.
     FCTX            /BUTPAR/        R*4     BUTPAR.INC
                     Normalized 3dB cut-off frequency of transmitter
                     filter.
     IFILRX          /BUTPAR/        I*2     BUTPAR.INC
                     Receiver filter indicator.
                             0 = MD-918 receiver filter.  Also means
                                 filter is a Butterworth cascaded with a
                                 rectangular impulse response filter of
                                 duration equal to symbol duration.
                             1 = (not allowed)
                             2 = AN/TRC-170 receiver filter.  Also means
                                 filter is a Butterworth.
     IFILTX          /BUTPAR/        I*2     BUTPAR.INC
                     Transmitter filter indicator.
                             0 = MD-918 transmitter filter.  Also means
                                 filter is a Butterworth cascaded with a
                                 rectangular impulse response filter of
                                 duration equal to symbol duration.
                             1 = AN/TRC-170 transmitter filter.  Also means
                                 filter is a cascade of Butterworth filter
                                 with rectangular impulse response filter
                                 of duration equal to half symbol duration.
                             2 = (not allowed)
```

NPOLRX	/BUTPAR/	R*4	BUTPAR.INC
	Number of poles in the receive Butterworth filter.		
NPOLTX	/BUTPAR/	I*2	BUTPAR.INC
	Number of poles in the transmit Butterworth filter.		

8.20 SPEC2

Subprogram name: C*8 Function SPEC2

Purpose: To calculate the spectrum (Fourier transform of impulse response) at normalized frequency F of the transmitter filter.

Calling sequence:
SPEC2 (F)

Contained in module: BUTFIL

Called by: BUTFIL

Calls: SPEC

Input arguments:

F	R*4	Frequency relative to the center of the band normalized to the symbol rate.

Output arguments:

SPEC2	C*8	Spectrum (Fourier transform of impulse response) at normalized frequency F of the transmitter filter.

Global variables input from common:

FCTX /BUTPAR/ R*4 BUTPAR.INC
Normalized 3dB cut-off frequency of transmitter filter.

IFILTX /BUTPAR/ I*2 BUTPAR.INC
Transmitter filter indicator.
- 0 = MD-918 transmitter filter. Also means filter is a Butterworth cascaded with a rectangular impulse response filter of duration equal to symbol duration.
- 1 = AN/TRC-170 transmitter filter. Also means filter is a cascade of Butterworth filter with rectangular impulse response filter of duration equal to half symbol duration.
- 2 = (not allowed)

NPOLTX /BUTPAR/ I*2 BUTPAR.INC
Number of poles in the transmit Butterworth filter.

CHAPTER 9

MD-918 MODEM CALCULATIONS

This section describes the MD-918 modem performance calculation routines:

Name	Description	User's Manual section
BERCAL	Short term performance calculation	2.8.1
BOTAC	Interference covariance matrices	2.8.1
CAC	Cascade of filter and channel power impulse response	NA
CAJI	Thermal noise covariance matrix	NA
CAKL	Signal covariance matrix C(K,L)	NA
CHANGE	Matrix utility	NA
DINT	Double integration	NA
EIGEN	Eigenvalues and eigenvectors	2.8.1
ELMES	Matrix conditioner	2.9.4
ERLANG	Butterworth filter calculation	NA
HQR	Eigenvalues	2.9.4
JAMCOM	Interference covariance matrix	NA
MATA	Matrix multiplication	NA
MATCO	Covariance matrices	NA
MDTS	MD-918 modem performance	2.8
MINV	Matrix inversion	NA
ORDER	Order values in vector	NA
PDFCON	Coefficients of PDF	2.8.1.3
PROUT	Print out outages and BER	NA
PSINE	Sine product	NA
PWRSPC	Power spectrum - receiver-interferer	2.7.3
RJCFCN	Receiver-interferer correlation function	2.7.3
SASEQ	Chip sequence	NA
SIGIN	Set parameters	NA
SINC	SINC function	NA
SQTMAT	Matrix square root	2.8.1

TPSPEC	Power spectrum - Butterworth .	2.7
TPSPJ	Power spectrum - interferer . .	2.7.3
TSINC	Triangle and SINC convolution .	NA
XNOR	Gaussian PDF	NA

The main routine for this section is MDTS. The MD-918 calculations are described in section 2.8 of the User's Manual.

Figure 2-5 is a top level flowchart for MD-918 modem performance calculations at a functional level. In most cases the blocks correspond to one or more subprograms. The test blocks (diamonds) correspond to logical branches which are decided by the user's choices of input data.

NOTE

In most cases the sections in the User's Manual describe the coded equations as well as the theory behind them. NA denotes routines that are programming utilities such as finding indices, setting pointers, etc.

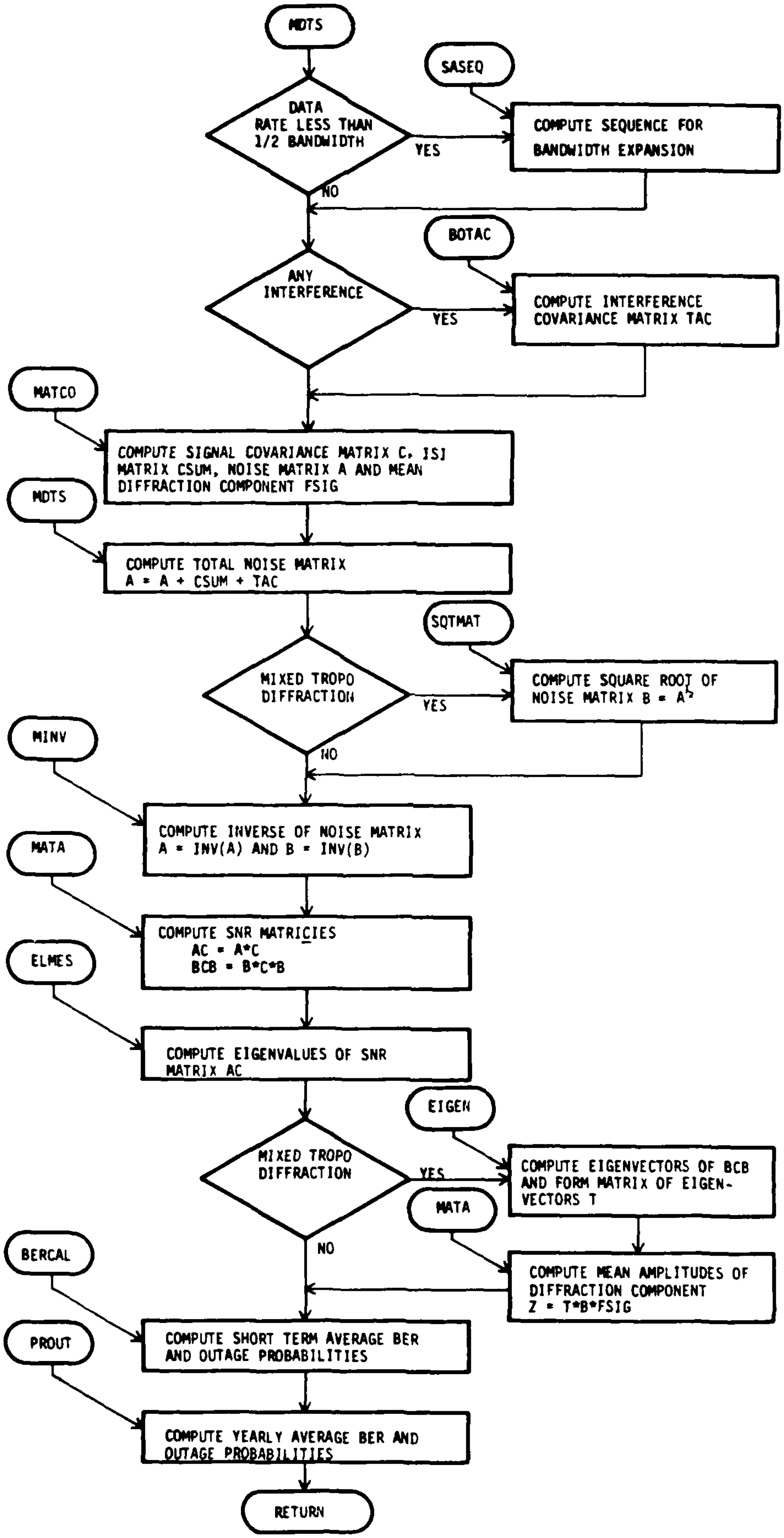


Figure 2-5 Flow Chart for the MD-918 Modem Performance Calculations

9.1 BERCAL

Subprogram name: Subroutine BERCAL

Purpose: BERCAL computes the outage probability, fade outage per call minute, average bit error rate and 1000-bit block error probability as a function of mean hourly scatter SNR, specular component SNR, DSNR, for the MD-918 modem. This version accounts for decorrelation of long term fading of main and elevated beams.

Reference: P. Monsen 'Theoretical and measured performance of a DFE modem on a fading multipath channel.', IEEE Transactions on Communications, Vol. COM-25, No. 10, October, 1977, pp. 1144-1153.

Calling sequence:

```
CALL BERCAL(VJ4,JPOW,JSR,CRATE,IBER,SNR,U,BOUT,ABE,
SOUT,NOUT,V,F,K3,K6,ASNR,STSNR,FOUT,CGAIN,CORFAC,IFPKAV,
XSCAT,XDIFR,G,DSNR,ADSNR,DSTSNR,PTYPE,IFDSNR)
```

Contained in module: BERCAL

Called by: MDTS

Calls: ERLANG PDFCON XNOR

Input arguments:

VJ4	R*4	Gain of strongest implicit diversity branch of elevated beam.
JPOW	R*8	Interferer power density in dBm/Hz. If JPOW is less than -174 dBm (background noise level), BERCAL assumes no interference.
JSR	R*8	Interferer to signal power ratio in dB.
CRATE	R*4	Code rate.
IBER	I*2	Integer counter used to indicate the completion of averaging over distributions of SNR and DSNR (IBER = 2).
SNR	R*4	Mean hourly SNR in dB at which outage probability is to be calculated.
F	R*4	Scatter SNR as a ratio. Includes modem degradation.
K3	I*2	Pointer, with K6, to blocks of eigenvalues.
K6	I*2	Pointer, with K3, to blocks of eigenvalues.
ASNR	R*4	Mean of long term distribution of scatter SNR (Eb/No) in dB.
STSNR	R*4	Standard deviation of long term distribution of scatter SNR (Eb/No) in dB.
CGAIN(3)	R*4	Coding gain for each BER threshold.
CORFAC	R*4	Correction factor for STSNR due to decorrelation of long term variability for angle diversity.

IFPKAV	I*2	Switch to print outage probability as a function of peak scatter SNR (Ep/No) when IFPKAV = 1, or average scatter SNR (Eb/No) when IFPKAV = 0.
XSCAT	R*4	Scatter SNR as a fraction of total power.
XDIFR	R*4	Specular component SNR as a fraction of total power.
G	R*4	Specular component SNR as a ratio.
DSNR	R*4	Specular component SNR in dB.
ADSNR	R*4	Mean of long term distribution of specular component SNR in dB.
DSTSNR	R*4	Standard deviation of long term distribution of specular component SNR in dB.
PTYPE	I*2	Indicates whether path is pure scatter (PTYPE = 0) or mixed scatter/diffraction (PTYPE = 1).
IFDSNR	L*4	Flag indicating which values of DSNR to output.

Output arguments:

U(49)	R*4	Eigenvalues which are the gains of the implicit diversity paths. The first three gains correspond to the main beam path.
BOUT(3,4)	R*4	Yearly average outage probabilities for the different BER thresholds and diversity configurations specified (see table).
ABE(4)	R*4	Yearly average 1000-bit block error probability for each diversity configuration specified (see table).
SOUT	R*4	Normalization constant for averaging over yearly distribution of SNR and DSNR.
NOUT	R*4	Number of terms in numerical integration over distribution of SNR and DSNR.
V(196)	R*8	Inverse of SNR per implicit diversity.
FOUT(3,4)	R*4	Yearly average fade outage per call minute for the different BER thresholds and diversity configurations specified (see table).

Global variables input from common:

APOW /MCOM4/ R*4 MCOM.INC
Angle diversity squint loss as a ratio.

BER(3) /ERAD/ R*4 ERAD.INC
Bit error rate thresholds of interest. Set to 1E-3, 1E-4 and 1E-5 in data statement.

DIVTYP /MCOM2/ I*2 MCOM.INC
Diversity configuration indicator. Default is 0.
0 = 2 receive antennas; 2S 2S/2F 2S/2A 2S/2A/2F
1 = 1 receive antenna; 2A 2F 2F/2A
2 = 2 transmit,
2 receive antennas; 2S/2P 2S/2P/2A
3 = Not used

```
                            4 = User supplied parameters
                           S = Space  F = Frequency  A = Angle  P = Polarization
           LOUT            /LUNS/          I*2     LUNS.INC
                           FOR002.DAT output unit number.
           NERT            /MCOM2/         I*2     MCOM.INC
                           Bit error rate threshold indicator for yearly fade
                           outage probability calculation.  Default is 2.
                                  0 = All three thresholds
                                  1 = For 10**(-3) only
                                  2 = For 10**(-4) only
                                  3 = For 10**(-5) only
```

9.2 BOTAC

Subprogram name: Subroutine BOTAC

Purpose: Initialize C(KK,KK), A(KK,KK), BOUT(3,4), and ABE(4) arrays. Compute interferer covariance matrix TAC(KK,KK) for JPOW > -174 according to RF filtering specified through parameters IBW and JFILT. IBW specifies whether the receiver has an RF/IF filter (IBW > 0) or not (IBW = 0). If the receiver does not have an RF filter, JFILT indicates whether the interference covariance matrix calculation includes ground reflections (JFILT = 1) or not (JFILT = 0).

Calling sequence:

```
CALL BOTAC (K,KK,K1,JPOW,JBW,TZ,C,A,TAC,BOUT,NOUT,ABE,FOUT,
BWR,ASEP,JANG)
```

Contained in module: BOTAC

Called by: MDTS

Calls: JAMCOM, RJCFCN, TSINC

Input arguments:

K	I*2	Flag: = 1 for K1 = 3; = 0 for K1 = 1.
JPOW	R*8	Interference power density in dBm/Hz.
JBW	R*8	Interference normalized bandwidth.
TZ	R*4	Time delay between interference signal received on two horizontally spaced antennas. It is a function of antenna separation and interferer angle of arrival. (See MDTS.)
BWR	R*4	Receive antenna beamwidth in degrees.
ASEP	R*4	Separation distance between receiving antennas in meters.
JANG	R*8	Interference off-borsight angle of arrival in degrees.

Output arguments:

KK	I*2	Dimension of A,C, and TAC arrays. Maximum is 14.
K1	I*2	Number of taps in forward equalizer.
C(KK,KK)	R*4	Signal covariance matrix initialized to zero. Dimensioned as 14x14.
A(KK,KK)	R*4	Noise covariance matrix initialized to zero. Dimensioned as 14x14.
TAC(KK,KK)	R*4	Interferer covariance matrix calculated according to RF filtering specified through IBW and JFILT parameters. Dimensioned as 14x14.
BOUT(3,4)	R*4	Outage probability array initialized to zero.
NOUT	R*4	Number of short term outage probability

```
                                   calculations initialized to zero.
     ABE(3,4)          R*4     Average block error array initialized to zero.
     FOUT(3,4)         R*4     Fade outage array initialized to zero.

Global variables input from common:
     IBW               /MCOM2/          I*2     MCOM.INC
                       Switch indicating type of RF bandwidth constraint to
                       be used on desired signal.  Default is 0.
                          0 = No RF filtering
                          1 = Filter determined from 99% bandwidth constraint
                          2 = Filter chosen to meet FCC Mask.  (FCC-19311)
                          3 = Filters are user specified
     JFILT             /MCOM2/          I*2     MCOM.INC
                       Interference covariance matrix calculation indicator.
                       Only used when IBW equals 0, otherwise ignored.
                       Default is 0.
                                 0 = Interferer covariance matrix calculation
                                     done in subroutine ROTAC
                                 1 = Interferer covariance matrix calculation
                                     done in subroutine JAMCOM
     LOUT              /LUNS/           I*2     LUNS.INC
                       FOR002.DAT output unit number.
     NJR               /RZ4/            I*2     RZ4.INC
                       Number of sample points for RJCOR.
     TAPW              /MCOM4/          R*4     MCOM.INC
                       Normalized tapwidth for MD-918.  Default is .5.
                       Range is 0.25 through 1.0
```

9.3 CAC

Subprogram name: Function CAC

Purpose: Computes G(XZ-SK) * G(XZ-SL) * ZQ(TO-XZ) when SIGMA > 0 and G(XZ-SK) when SIGMA < 0. G(X) is the impulse response of the cascade of the transmitter and receiver filters and ZQ(X) is the power per unit delay or correlation per unit delay of the perceived scatter signal component.

Calling sequence:
CAC (XZ,SK,SL,SIGMA,TO,ZQ)

Contained in module: DINT

Called by: DINT MATCO

Calls: FILSIX SINC

Input arguments:

XZ	R*4	Normalized time at which function is to be evaluated.
SK	R*4	Tap sampling time relative to AFE center tap.
SL	R*4	Same as SK.
SIGMA	R*4	Normalized delay spread of scatter component.
TO	R*4	Normalized sampling time for center tap relative to centroid of power per unit delay profile.
ZQ	R*4	Power per unit delay or correlation per unit delay profile for scatter signal.

Output arguments:

CAC	R*4	Value of G(XZ-SK) * G(XZ-SL) * ZQ(TO-XZ).

Global variables input from common:

```
DELPBZ        /RZ1/         R*4
              Resolution of a delay cell in seconds.  Same as DELPB
              in /PDATA/.
DIVTYP        /MCOM2/       I*2     MCOM.INC
              Diversity configuration indicator.  Default is 0.
               0 = 2 receive antennas; 2S    2S/2F    2S/2A 2S/2A/2F
               1 = 1 receive antenna;  2A    2F       2F/2A
               2 = 2 transmit,
                   2 receive antennas; 2S/2P 2S/2P/2A
               3 = Not used
               4 = User supplied parameters
              S = Space  F = Frequency  A = Angle  P = Polarization
DRATE         /MCOM4/       R*4     MCOM.INC
              Data rate in bits/second.  Default is 6.6E6.
DU(256)       /RZ/          R*8     RZ.INC
              Signal response after PN sequence correlation.
ICORR         /MCOM2/       I*2     MCOM.INC
```

```
                 Multipath profile correlation indicator.  Default
                 is 2.
                    0 = Profile of the form X * exp(-A*X) -- used for
                        debugging
                    1 = Computed multipath profile; no beam correlation
                    2 = Computed multipath profile; beam correlation.
IFILE            /MCOM2/         I*2     MCOM.INC
                 Pointer to multipath profile.
JQ2M             /MCOM4/         I*2     MCOM.INC
                 Pointer to centroid of lower beam troposcatter signal
                 power per unit delay profile.
KGAIN            /RZ/            I*2     RZ.INC
                 Integer ratio of bandwidth to data rate.
NDELQ            /MCOM4/         I*2     MCOM.INC
                 Number of non-zero elements of troposcatter power per
                 unit delay profiles Q(NDELQ,1).
NIP              /RZ/            I*2
                 Initialization constant for numerical equalizer
                 covariance matrix calculation.
NTR              /RZ4/           I*2     RZ4.INC
                 Number of samples for calculating transmit-receive
                 filter impulse response (TRFILT).
PCON             /RZ/            R*8     RZ.INC
                 Normalization factor for probability integral.
PULSE            /RZ/            I*2     RZ.INC
                 Switch controlling MD-918 pulse shape after
                 transmitter-receiver filtering.
                         PULSE = 0   Triangle
                               = 1   OQPSK matched filter
                               = 2   Sinc pulse, bandwidth equal to 1
                               = 5   RF filtering included
                 Set to 0 if IBW = 0 or KGAIN > 1.
                 Set to 5 if IBW > 0 and KGAIN = 1.
TRFILT(128)      /RZ4/           R*4     RZ4.INC
                 Transmit-receive filter impulse response.
XTRO             /RZ4/           R*4     RZ4.INC
                 Time origin for transmit-receive filter impulse
                 response (TRFILT), ie, X is TRFILT(X+XTRO).
XTRINC           /RZ4/           R*4     RZ4.INC
                 Sample interval for calculation of transmit-receive
                 filter impulse response (TRFILT).
```

9.4 CAJI

Subprogram name: Subroutine CAJI

Purpose: Calculate thermal noise covariance matrix for AFE taps.

Calling sequence:
CALL CAJI (K,A)

Contained in module: CAJI

Called by: MATCO

Calls: NONE

Input arguments:

K	I*2	Number of taps on either side of center tap of AFE.

Output arguments:

A(14,14)	R*4	Thermal noise covariance matrix.

Global variables input from common:

```
DU(256)     /RZ/        R*8    RZ.INC
            Signal response after PN sequence correlation.
NB          /RI2/       I*2    RI2.INC
            Number of elements accessed in arrays DU, DX and DY.
PULSE       /RZ/        I*2    RZ.INC
            Switch controlling MD-918 pulse shape after
            transmitter-receiver filtering.
                    PULSE = 0   Triangle
                          = 1   OQPSK matched filter
                          = 2   Sinc pulse, bandwidth equal to 1
                          = 5   RF filtering included
            Set to 0 if IBW = 0 or KGAIN > 1.
            Set to 5 if IBW > 0 and KGAIN = 1.
RCOR(32)    /RZ4/       R*4    RZ4.INC
            Correlation function of the receive filter in steps
            equal to the tapwidth (TAPW) for MD-918 modem, or
            equal to 1/RATE for AN/TRC-170 or DAR modem.
TAPW        /MCOM4/     R*4    MCOM.INC
            Normalized tapwidth for MD-918.  Default is .5.
            Range is 0.25 through 1.0
```

Pointer to multipath profile.

IFPRNT	I*2	Switch to enable debug print out (=1).
DUPOW	R*4	Ratio of diffraction signal component on upper beam to that on lower beam.
IFDSNR	L*4	Switch to enable print out of covariance matrices for mixed scatter/diffraction propagation conditions.

Output arguments:

C(14,14)	R*4	Scatter signal covariance matrix for AFE taps.
C0(7,7)	R*4	Scatter signal covariance sub-matrix for lower beam AFE taps.
C1(7,7)	R*4	Scatter signal covariance sub-matrix for upper beam AFE taps.
C2(7,7)	R*4	ISI covariance matrix for lower beam taps.
C3(7,7)	R*4	ISI covariance matrix for upper beam taps.
C4(7,7)	R*4	Scatter signal correlation sub-matrix for lower/upper beam (DIVTYP = 0,1) or crossed paths (DIVTYP = 2).
CSUM(14,14)	R*4	ISI covariance matrix for AFE taps.
AF(14,14)	R*4	Thermal noise covariance matrix for AFE taps.
A(14,14)	R*4	Same as AF.

Global variables input from common:

DIVTYP /MCOM2/ I*2 MCOM.INC
Diversity configuration indicator. Default is 0.
0 = 2 receive antennas; 2S 2S/2F 2S/2A 2S/2A/2F
1 = 1 receive antenna; 2A 2F 2F/2A
2 = 2 transmit,
2 receive antennas; 2S/2P 2S/2P/2A
3 = Not used
4 = User supplied parameters
S = Space F = Frequency A = Angle P = Polarization

LDEBUG /LUNS/ I*2 LUNS.INC
Debug output unit. Always the same as LOUT but used to uniquely identify the write statements.

LISI /MCOM2/ I*2 MCOM.INC
Number of future Intersymbol Interference (ISI) contributors considered in MD-918 performance calculation. Default is 2.

LOUT /LUNS/ I*2 LUNS.INC
FOR002.DAT output unit number.

TAPW /MCOM4/ R*4 MCOM.INC
Normalized tapwidth for MD-918. Default is .5. Range is 0.25 through 1.0

TDIFF /MCOM4/ R*4 MCOM.INC
Normalized relative delay between lower and upper beam.

Global variables output to common:

IFILE /MCOM2/ I*2 MCOM.INC

9.14 MATCO

Subprogram name: Subroutine MATCO

Purpose: To compute the troposcatter signal covariance matrix C and sub-matrices C0, C1, C4; thermal noise covariance matrices A and AF; ISI covariance matrix CSUM, and ISI sum-matrices C2 and C3; and mean diffraction amplitude vector FSIG for the MD-918 AFE taps.

Calling sequence:

```
CALL MATCO (SIGMA,SIGM1,C,C0,C1,C2,C3,C4,CSUM,Q,AF,A,K,K1,
KK,T0,TA,TSCAT,JPOW,ELOSS,XSCAT,XDIFR,PTYPE,JQDM,IFPRNT,DUPOW, IFDSNR)
```

Contained in module: MATCO

Called by: MDTS

Calls: CAC, CAJI, CAKL

Input arguments:

SIGMA	R*4	Normalized delay spread of scatter signal in lower beam.
SIGM1	R*4	Normalized delay spread of scatter signal in upper beam.
Q(100,7)	R*4	Power per unit delay and correlation per unit delay for scatter signal in each receiving aperture.
K	R*4	Flag: 1 for K1 = 3, 0 for K1 = 1.
K1	R*4	Number of taps in AFE.
KK	R*4	Total number of correlated taps (dimension of covariance matrix) for angle and/or space diversity.
T0	R*4	Normalized sampling time (relative to scatter component mean time of arrival) for lower beam.
TA	R*4	Normalized sampling time (relative to scatter component mean time of arrival) for upper beam.
TSCAT	R*4	Normalized relative delay between scatter and diffraction component.
JPOW	R*8	Interference power density in dBm/Hz.
ELOSS	R*8	Squint loss for scatter signal in upper beam in dB.
XSCAT	R*4	Fraction of scatter signal power.
XDIFR	R*4	Fraction of diffraction signal power.
PTYPE	R*4	Indicates whether pure scatter (PTYPE = 0) or mixed scatter/diffraction path (PTYPE = 1).
JQDM	R*4	Index in power per unit delay profile corresponding to delay bin of the specular (diffraction) component.

9.13 MATA

Subprogram name: Subroutine MATA

Purpose: IBM routine for matrix multiplication:
S(M,N) * T(N,L) = ST(M,L).

Calling sequence:
```
CALL MATA (S,T,ST,M,N,L,NSR,NSC,NTR,NTC,NSTR,NSTC)
```

Contained in module: MATOPS

Called by: MDTS, SQTMAT

Calls: ERROR

Input arguments:

S(NSR,NSC)	R*4	Input matrix to be right multiplied by T.
T(NTR,NTC)	R*4	Input matrix.
M	I*2	Number of actual rows of matrices S and ST.
N	I*2	Number of actual columns of matrix S and rows of matrix T.
L	I*2	Number of actual columns of matrices T and ST.
NSR	I*2	Row dimension of matrix S. No maximum set.
NSC	I*2	Column dimension of matrix S. No maximum set.
NTR	I*2	Row dimension of matrix T. No maximum set.
NTC	I*2	Column dimension of matrix T. No maximum set.
NSTR	I*2	Row dimension of matrix ST. No maximum set.
NSTC	I*2	Column dimension of matrix ST. No maximum set

Output arguments:

ST(NSTR,NSTC)	R*4	Matrix product of S(.) and T(.).

	is the main receive antenna.		
TAPW	/MCOM4/	R*4	MCOM.INC
	Normalized tapwidth for MD-918. Default is .5. Range is 0.25 through 1.0		
THER	/PATHGE/	R*4	TROCOM.INC
	Radio horizon elevation angle at receive site in radians.		

Global variables output to common:

A	/PATHGE/	R*4	TROCOM.INC
	Effective earth radius in meters.		

9.12 JAMCOM

Subprogram name: Subroutine JAMCOM

Purpose: Calculate covariance matrix for one interferer with one direct path and one reflected path. (Reflections off a horizontal surface.) Angles of arrival and delay are assumed identical for both antennas.

Calling sequence:

```
CALL JAMCOM (TAC, BWR, ASEP, JANG)
```

Contained in module: JAMCOM

Called by: BOTAC

Calls: TSINC

Input arguments:

BWR	R*4	3dB beamwidth of receiving antenna in degrees.
ASEP	R*4	Separation between receiving antennas in meters.
JANG	R*8	Interferer angle of arrival in degrees.

Output arguments:

TAC(14,14)	R*4	Covariance matrix.

Global variables input from common:

ATTEN	/MCOM4/	R*4	MCOM.INC
	Ratio of interferer signal amplitude on antenna 2 to that at antenna 1. Set to 1 internally.		
BW	/SYSTRN/	R*4	TROCOM.INC
	Bandwidth in Hertz. Default is 7 MHz.		
DRATE	/MCOM4/	R*4	MCOM.INC
	Data rate in bits/second. Default is 6.6E6.		
ELANG(10)	/MCOM4/	R*4	MCOM.INC
	Interferer elevation angles in degrees. Default is 0.		
HRN	/PATHGE/	R*4	TROCOM.INC
	Receive antenna height above sea level in meters.		
JREFL	/MCOM2/	I*2	MCOM.INC
	Indicates whether specular reflection is to be included in interferer covariance matrix calculation (JREFL = 1) or not (JREFL = 0). Default is 0.		
LANG	/MCOM2/	I*2	MCOM.INC
	Pointer to data array elements containing interferer azimuth and elevation angles.		
PI	/CONSTA/	R*4	CONSTANTS.INC
	Constant Pi = 3.141592654.		
PSIREO(NRMX)	/ANTENN/	R*4	TROCOM.INC
	Array of receiver beam boresight elevations above radio horizon in radians, ie, angle at which each antenna is aimed relative to the horizon. PSIREO(1)		

9.11 HQR

Subprogram name: Subroutine HQR

Purpose: Find eigenvalues of matrix H.

Calling sequence:
CALL HQR (NM,N,LOW,IGH,H,WR,WI,IERR)

Contained in module: ELMES

Called by: EIGV, MDTS

Calls: NONE

Input arguments:

NM	I*2	Dimension of matrix H. No maximum set.
N	I*2	Dimension of matrix H and arrays WR and WI. No maximum set.
LOW	I*2	Pointer to first row (or column) of square sub-matrix of H.
IGH	I*2	Pointer to last row (or column) of square sub-matrix of H.
H(NM,N)	R*8	Square matrix whose eigenvalues are to be found.

Output arguments:

H(NM,N)	R*8	Square matrix whose eigenvalues are to be found.
WR(N)	R*8	Real part of eigenvalue.
WI(N)	R*8	Imaginary part of eigenvalue.
IERR	I*2	Error flag. 0 for no error; > 0 for error

9.10 ERLANG

Subprogram name: Function ERLANG

Purpose: For I = 1,2,3 or 4 ERLANG = X**(I-1) * EXP(-A*X) / (I-1)!
otherwise ERLANG = 10**38 for precision limits. If A*X > 85
ERLANG = 0. (Where: I = Integer A; X = Real.)

Calling sequence:
ERLANG (I,A,X)

Contained in module: ERLANG

Called by: BERCAL, PDF, PDFSUM

Calls: NONE

Input arguments:

I	I*2	Argument of factorial and power in ERLANG function.
A	R*8	Parameter of exponent in ERLANG function.
X	R*8	Argument of ERLANG function.

Output arguments:

ERLANG	R*8	Value of X**(I-1) * EXP(-A*X) / (I-1)!.

9.9 ELMES

Subprogram name: Subroutine ELMES

Purpose: Conditions matrix A prior to HQR finding eigenvalues and eigenvectors.

Calling sequence:
CALL ELMES (NM,N,LOW,IGH,A,INT)

Contained in module: ELMES

Called by: EIGV, MDTS

Calls: NONE

Input arguments:

NM	I*2	Row dimension of matrix A. No maximum set.
N	I*2	Column dimension of matrix A. No maximum set.
LOW	I*2	Pointer to first row (or column) of square sub-matrix.
IGH	I*2	Pointer to last row (or column) of square sub-matrix. Also, dimension of vector INT. No maximum set.
A(NM,N)	R*8	Matrix to be conditioned.

Output arguments:

A(NM,N)	R*8	Conditioned matrix.
INT(IGH)	I*2	Pointer to lowest value in each row of A.

9.8 EIGEN

Subprogram name: Subroutine EIGEN

Purpose: Compute eigenvalues and eigenvectors of a real symmetric matrix.

Reference: The process used is the diagonalization method originated by Jacobi and adapted by Von Neuman for large computers as found in 'Mathematical Methods for Digital Computers', edited by A. Ralston and H.S. Wilf, John Wiley and Sons, New York, 1962, Chapter 7.

Calling sequence:
CALL EIGEN (A,R,N,MV)

Contained in module: EIGEN

Called by: MDTS SQTMAT

Calls: NONE

Input arguments:

A(N)	R*4	Original matrix (symmetric). Destroyed in computation. Resultant eigenvalues are stored in diagonal of matrix A in descending order. This matrix must be real symmetric and must not be in the same location as matrix R. Matrix A must also be stored in Storage Mode 1, which means that only the upper right triangle is stored by columns through each diagonal element: A(1,1), A(1,2), A(2,2), A(1,3), etc. into vector form.
N	I*2	Order of matrices A and R. No limit set on size.
MV	I*2	Input code. 0 = Compute eigenvalues and eigenvectors. 1 = Compute eigenvalues only. (R need not be dimensioned but must still appear in calling sequence.)

Output arguments:

A(N)	R*4	Original matrix (symmetric). Destroyed in computation. Resultant eigenvalues are stored in diagonal of matrix A in descending order. This matrix must be real symmetric (storage mode 1) and must not be in the same location as matrix R.
R(N)	R*4	Resultant matrix of eigenvectors. Stored columnwise, in same sequence as eigenvalues.

NDELQ	/MCOM4/	I*2	MCOM.INC
	Number of non-zero elements of troposcatter power per unit delay profiles Q(NDELQ,1).		
PULSE	/RZ/	I*2	RZ.INC
	Switch controlling MD-918 pulse shape after transmitter-receiver filtering. PULSE = 0 Triangle = 1 OQPSK matched filter = 2 Sinc pulse, bandwidth equal to 1 = 5 RF filtering included Set to 0 if IBW = 0 or KGAIN > 1. Set to 5 if IBW > 0 and KGAIN = 1.		
TDIFF	/MCOM4/	R*4	MCOM.INC
	Normalized relative delay between lower and upper beam.		

9.7 DINT

Subprogram name: Subroutine DINT

Purpose: Integrates CAC = G(X-BK)G(X-BL)Q(TO-X) over (XL,XH) where:
G(X) = Fixed filter response.
Q(X) = Multipath profile.

Calling sequence:
CALL DINT (SIGMA,BK,BL,Y,TO,Q,PTYPE,JQDM)

Contained in module: DINT

Called by: MDTS CAKL

Calls: CAC

Input arguments:

SIGMA	R*4	Normalized delay spread of scatter component.
BK	R*4	Tap sampling time relative to AFE center tap.
BL	R*4	Same as BK.
TO	R*4	Normalized sampling time for center tap relative to centroid of power per unit delay profile.
Q	R*4	Power per unit delay profile or correlation per unit delay profile.
PTYPE	I*2	Indicates whether path is mixed scatter/diffraction (PTYPE = 1) or pure scatter path (PTYPE = 0).
JQDM	I*2	Index in power per unit delay profile corresponding to delay bin of the specular (diffraction) component.

Output arguments:

Y	R*4	Result of integration.

Global variables input from common:

DELPBZ /RZ1/ R*4
Resolution of a delay cell in seconds. Same as DELPB in /PDATA/.

DRATE /MCOM4/ R*4 MCOM.INC
Data rate in bits/second. Default is 6.6E6.

ICORR /MCOM2/ I*2 MCOM.INC
Multipath profile correlation indicator. Default is 2.
0 = Profile of the form X * exp(-A*X) -- used for debugging
1 = Computed multipath profile; no beam correlation
2 = Computed multipath profile; beam correlation.

JQ2M /MCOM4/ I*2 MCOM.INC
Pointer to centroid of lower beam troposcatter signal power per unit delay profile.

KGAIN /RZ/ I*2 RZ.INC
Integer ratio of bandwidth to data rate.

9.6 CHANGE

Subprogram name: Subroutine CHANGE

Purpose: Matrix utility operations defined by flag KIND.

Calling sequence:

```
CALL CHANGE (ARRAY,VECTOR,NACT,NDIM,KIND)
```

Contained in module: MATOPS

Called by: MDTS, SQTMAT

Calls: ERROR

Input arguments:

ARRAY(NACT,NACT)	R*4	Two-dimensional array (matrix). No limit set on size.
VECTOR(1)	R*4	One-dimensional array (vector). No limit to size set.
NACT	I*2	Actual physical dimensions of ARRAY in calling program. No maximum set.
NDIM	I*2	Number of rows and columns in input (output) matrix ARRAY.
KIND	I*2	Input flag: 1 = Pack symmetric matrix, ARRAY, into VECTOR by columns through each diagonal element. 2 = Copy VECTOR into doubly-subscripted ARRAY. 3 = Copy only diagonal elements from VECTOR into ARRAY and zero off-diagonal elements (as in a unitary matrix).

Output arguments:

ARRAY(NACT,NACT)	R*4	Two-dimensional array (matrix). No limit set on size.
VECTOR(1)	R*4	One-dimensional array (vector). No limit to size set.

9.5 CAKL

Subprogram name: Subroutine CAKL

Purpose: Compute scatter signal covariance matrix C(K,L) where:
K,L = (-KK,-KK+1,-KK+2,...,+KK).
Number of rows and columns (AFE taps) is therefore equal to 2*KK+1.
Covariance matrix is defined as integral of:
$$G_i(X-KT) * G_j(X-LT+(j-i)*DIFF) * Q(TO-X)$$
where G_i and G_j are the impulse response of the cascade of transmitter and receiver filters for diversity ports i and j. Q(X) is the power per unit delay function of the scatter component if i = j and the correlation per unit delay profile otherwise.

Calling sequence:

```
CALL CAKL (KK,SIGMA,C,TO,DIFF,Q,PTYPE,JQDM)
```

Contained in module: DINT

Called by: MATCO

Calls: DINT

Input arguments:

KK	I*2	Number of taps on either side of the center tap of the AFE.
SIGMA	R*4	Normalized delay spread of scatter component.
TO	R*4	Normalized sampling time relative to centroid of scatter component power per unit delay profile. TO > 0 increases future ISI.
DIFF	R*4	Delay compensation for angle diversity systems.
Q	R*4	Power per unit delay profile or correlation per unit delay profile.
PTYPE	I*2	Indicates whether path is mixed scatter/diffraction (PTYPE = 1) or pure scatter path (PTYPE = 0).
JQDM	I*2	Index in power per unit delay profile corresponding to delay bin of the specular (diffraction) component.

Output arguments:

C	R*4	Scatter signal covariance matrix for AFE taps.

Global variables input from common:

TAPW /MCOM4/ R*4 MCOM.INC
Normalized tapwidth for MD-918. Default is .5.
Range is 0.25 through 1.0

9.15 MDTS

Subprogram name: Subroutine MDTS

Purpose: Computes MD-918 modem performance assuming LISI symbols of intersymbol interference (ISI). Performance under mixed scatter/diffraction propagation conditions also includes the ISI due to the 4th and 5th past symbols. Assumes ISI is Gaussian.

Reference: P. Monsen 'Theoretical and measured performance of a DFE modem on a fading multipath channel.', IEEE Transactions on Communications, Vol. COM-25, No. 10, October, 1977, pp. 1144-1153. See also 'Link analysis plan'. Interim technical report no. CSA-76-8085-3, October 1978, Contract #DAAB07-76-C-8085.

Calling sequence:
```
CALL MDTS (TAU22,TAU23,ELOSS,RHO,ASNR,ADSNR,Q,DUPOW,JPOW,
JBW,BWT,BWR,ASEP,CORFAC,BOUT,FOUT,FJSEP,PTYPE,TEMPA,JQDM)
```

Contained in module: MDTS

Called by: TROPO

Calls:

BERCAL	BOTAC	CHANGE	DINT	EIGEN	ELMES	ERROR	HQR
MATA	MATCO	MINV	ORDER	PROUT	SASEQ	SIGIN	SINT
SQTMAT	XNOR						

Input arguments:

TAU22	R*8	Delay spread on lower beam in nsec.
TAU23	R*8	Delay spread on upper beam in nsec.
ELOSS	R*8	Upper beam squint loss for scatter component in dB or sidelobe loss for interference.
RHO	R*8	Correlation between lower and upper beam long-term variability of scatter component.
ASNR	R*4	Median and/or yearly average value of scatter path SNR in dB.
ADSNR	R*4	Yearly average value of diffraction path SNR in dB.
Q(100,7)	R*4	Multipath delay/correlation profile array.
DUPOW	R*4	Ratio of diffraction component on upper beam to diffraction component on lower beam.
JPOW	R*8	Interference signal power density in dBm/Hz.
JBW	R*8	Interfering signal bandwidth in Hz.
BWT	R*4	Transmit antenna beamwidth in degrees.
BWR	R*4	Receive antenna beamwidth in degrees.
ASEP	R*4	Receiver antenna separation in meters.
CORFAC	R*4	Correction factor computed by LTCORR. CORFAC is used in subroutine BERCAL to scale STSNR multiplicatively when angle diversity is used.
FJSEP	R*4	Frequency separation between desired signal and interference signal in Hertz.

```
     PTYPE    I*2     Variable which indicates whether propagation
                      mechanism is pure troposcatter (0 or 10) or mixed
                      troposcatter-diffraction (1 or 11).
     TEMPA(7) R*4     Average relative delay of scatter component.
     JQDM     I*2     Index in the multipath profile corresponding to
                      the delay of the specular component.

Output arguments:
     BOUT(3,4)        R*4     Yearly average outage probability for each
                              bit error rate threshold specified and 2S/2F
                              and 2S diversity configurations.
     FOUT(3,4)        R*4     Yearly average fade outage per call minute for
                              each bit error rate threshold specified and
                              2S/2F and 2S diversity configurations.

Global variables input from common:
     CODE             /MCOM4/          L*4     MCOM.INC
                      Flag for coding.
     DEL              /SUMP/           R*4     CURVE.INC
                      Diffraction path delay relative to a straight line
                      path in seconds.
     DIVTYP           /MCOM2/          I*2     MCOM.INC
                      Diversity configuration indicator.  Default is 0.
                       0 = 2 receive antennas; 2S    2S/2F    2S/2A 2S/2A/2F
                       1 = 1 receive antenna;  2A    2F       2F/2A
                       2 = 2 transmit,
                          2 receive antennas; 2S/2P 2S/2P/2A
                       3 = Not used
                       4 = User supplied parameters
                      S = Space  F = Frequency  A = Angle  P = Polarization
     DRATE            /MCOM4/          R*4     MCOM.INC
                      Data rate in bits/second.  Default is 6.6E6.
     DSTSNR           /SUMP/           R*4     CURVE.INC
                      Standard deviation of diffracted signal long-term SNR
                      distribution in dB.
     ELANG(10)        /MCOM4/          R*4     MCOM.INC
                      Interferer elevation angles in degrees.  Default is 0.
     IBW              /MCOM2/          I*2     MCOM.INC
                      Switch indicating type of RF bandwidth constraint to
                      be used on desired signal.  Default is 0.
                         0 = No RF filtering
                         1 = Filter determined from 99% bandwidth constraint
                         2 = Filter chosen to meet FCC Mask.  (FCC-19311)
                         3 = Filters are user specified
     ICORR            /MCOM2/          I*2     MCOM.INC
                      Multipath profile correlation indicator.  Default
                      is 2.
                         0 = Profile of the form X * exp(-A*X) -- used for
                             debugging
                         1 = Computed multipath profile; no beam correlation
```

```
                          2 = Computed multipath profile; beam correlation.
          KGAIN         /RZ/            I*2     RZ.INC
                        Integer ratio of bandwidth to data rate.
          LERR          /LUNS/          I*2     LUNS.INC
                        Error output unit.
          LOUT          /LUNS/          I*2     LUNS.INC
                        FOR002.DAT output unit number.
          MANG          /MCOM2/         I*2     MCOM.INC
                        Number of values of interferer azimuth/elevation pairs
                        (JANG) for which outage calculations are to be made.
                        Default is 1.
          NANG          /RI2/           I*2     RI2.INC
                        NANG is 1 if there is angle diversity (default).
          NERT          /MCOM2/         I*2     MCOM.INC
                        Bit error rate threshold indicator for yearly fade
                        outage probability calculation.  Default is 2.
                                0 = All three thresholds
                                1 = For 10**(-3) only
                                2 = For 10**(-4) only
                                3 = For 10**(-5) only
          STSNR         /SUMP/          R*4     SUMP.INC
                        Standard deviation of troposcatter signal long-term
                        SNR distribution in dB.
          XANG(10)      /MCOM4/         R*4     MCOM.INC
                        Interferer azimuth angles in degrees.  Default is 0.

     Global variables output to common:
          APOW          /MCOM4/         R*4     MCOM.INC
                        Angle diversity squint loss as a ratio.
          IFILE         /MCOM2/         I*2     MCOM.INC
                        Pointer to multipath profile.
          LANG          /MCOM2/         I*2     MCOM.INC
                        Pointer to data array elements containing interferer
                        azimuth and elevation angles.
          NIP           /RZ/            I*2
                        Initialization constant for numerical equalizer
                        covariance matrix calculation.
          PCON          /RZ/            R*8     RZ.INC
                        Normalization factor for probability integral.
          PEAKAV        /RZ4/           R*4     RZ4.INC
                        Peak-to-average loss due to RF filtering in dB.
          TDIFF         /MCOM4/         R*4     MCOM.INC
                        Normalized relative delay between lower and upper
                        beam.
```

9.16 MINV

Subprogram name: Subroutine MINV

Purpose: IBM SSP Library routine. Matrix inversion.

Calling sequence:

```
CALL MINV (C,N,D,NC,ICON,B)
```

Contained in module: MINV

Called by: MDTS

Calls: *NONE*

Input arguments:

C(NC,NC)	R*4	Matrix to be inverted. Also may be returned here. No limit set on size.
N	I*2	Matrix order.
NC	I*2	Size of matrix C. No maximum set.
ICON	I*2	Control flag. 0 = Invert C and return determinant in D. 1 = Return determinant in D and leave C as is. 3 = On output for determinant = 0 4 = Ignore determinant = 0

Output arguments:

C(NC,NC)	R*4	Matrix to be inverted. Also may be returned here. No limit set on size.
D	R*4	Determinant returned.
B(1)	R*4	Working matrix.

9.17 ORDER

Subprogram name: Subroutine ORDER

Purpose: Store largest N values of R(K) in V(K) in decreasing size and order. For K < I < N+1 V(I) = 0.0.
--> NOTE: Do NOT use for K = N = 1 !!!!

Calling sequence:
CALL ORDER (K,R,V,N)

Contained in module: ORDER

Called by: EIGV, MDTS

Calls: ERROR

Input arguments:

K	I*2	Dimension of arrays R and V. No maximum set.
R(K)	R*8	Input array.
N	I*2	Number of values to return.

Output arguments:

V(K)	R*8	Output array.

Global variables input from common:

LERR	/LUNS/	I*2	LUNS.INC
	Error output unit.		

9.18 PDFCON

Subprogram name: Subroutine PDFCON

Purpose: Calculate coefficients in partial fractions expansion of Laplace transform F(S) of PDF for SNR, from list of negatives of roots of F(s). On return, roots are in descending order. Coefficients C((N-1)*ID + I) are such that the following two expansions for F(s) are equivalent:

F(s) = (R(1) / (S + R(1)))**NDIV *...* (R(NR) / (S + R(NR)))**NDIV

and,

F(s) = ...C((N-1)*NDIV + I) / (S + R(N))*NDIV-I + 1 ...

for N = 1,2,...NR; I = 1,2,...NDIV.

Reference: K. Miller, 'Engineering Mathematics', Dover Publications, 1963, pp. 214-215.

Calling sequence:

CALL PDFCON (NR,R,NDIV,C)

Contained in module: BERCAL

Called by: BERCAL

Calls: NONE

Input arguments:

NR	I*2	Number of roots. Dimension of vectors R and C. No maximum set on vector sizes but see NDIV for limitations on values.
R(NR)	R*8	Array of NR positive numbers, which are the negatives of the roots of F(s). These are positive numbers. On return, they are ordered in descending order.
NDIV	I*2	Multiplicity of roots. Must be 1, 2 or 4. For NDIV = 4, NR must be 1 or 3. For any illegal combination of NDIV and NR, PDFCON returns C(I) = 0.D0 for I = 1 through NR*NDIV (= NC).

Output arguments:

C(NR*NDIV)	R*8	Output array into which PDFCON puts the calculated coefficients. Dimensioned to 24, therefore, NR*NDIV must be no more than 24.

9.19 PROUT

Subprogram name: Subroutine PROUT

Purpose: To output to file FOR002.DAT yearly average outage probability, fade outage per call minute, and 1000-bit block error probability of MD-918 modem for each specified BER threshold and diversity configuration.

Calling sequence:
CALL PROUT (JPOW,DIVTYP,NOUT,N1,N2,SOUT,BOUT,FOUT,ABE,CGAIN, PTYPE)

Contained in module: PROUT

Called by: MDTS

Calls: NONE

Input arguments:

JPOW	R*8	Interference power density in dBm/Hz.
DIVTYP	I*2	Diversity configuration indicator.
NOUT	I*2	Total number of short term calculations performed.
N1	I*2	Index of largest BER threshold of interest.
N2	I*2	Index of smallest BER threshold of interest.
SOUT	R*4	Normalization for averaging of short term outage probabilities.
BOUT(3,4)	R*4	Outage probability for each BER threshold and diversity configuration (see table).
FOUT(3,4)	R*4	Fade outage per call minute for each BER threshold and diversity configuration: I = Index for BER threshold J = Index for varying diversity types, depending on the value of DIVTYP
ABE(4)	R*4	Average 1000-bit block error probability for each diversity configuration.
CGAIN	R*4	Coding gains for each BER threshold.
PTYPE	I*2	Indicates whether pure scatter (= 0) or mixed scatter/diffraction path (= 1).

Output arguments:

BOUT(3,4)	R*4	Outage probability for each BER threshold and diversity configuration (see table).
FOUT(3,4)	R*4	Fade outage per call minute for each BER threshold and diversity configuration: I = Index for BER threshold J = Index for varying diversity types, depending on the value of DIVTYP
ABE(4)	R*4	Average 1000-bit block error probability for each diversity configuration.

Global variables input from common:

```
BER(3)          /ERAD/          R*4     ERAD.INC
                Bit error rate thresholds of interest.  Set to 1E-3,
                1E-4 and 1E-5 in data statement.
LOUT            /LUNS/          I*2     LUNS.INC
                FOR002.DAT output unit number.
MDIST           /ERAD/          I*2     ERAD.INC
                Multipath distribution indicator.
                        0 = Only median multipath spread used(default)
                        1 = Multipath distribution used.  (Option not
                            currently available.)
NRAD            /ERAD/          I*2     ERAD.INC
                ERFAC indicator and loop counter.  Default is 1.
PFACT(3)        /ERAD/          R*4     ERAD.INC
                Cumulative probability distribution for effective
                earth radius factor.
                        For NRAD = 1    PFACT = 0.89
                                 = 2          = 0.1
                                 = 3          = 0.01
```

Global variables output to common:

```
ABEL(4)         /ERAD/          R*4     ERAD.INC
                Cumulative block error probability for each diversity
                configuration as specified by DIVTYP (averaged over
                multipath distribution, if any).
BOUTL(3,4)      /ERAD/          R*4     ERAD.INC
                Cumulative outage probability for each diversity
                configuration and error rate threshold (averaged
                over multipath distribution, if any).
FOUTL(3,4)      /ERAD/          R*4     ERAD.INC
                Cumulative fade outage per call minute for each
                diversity configuration and error rate threshold
                (averaged over multipath distribution, if any).
```

9.20 PSINE

Subprogram name: Function PSINE

Purpose: Calculates the product sin(.01 * XJ) * sin(.01 * DIN).

Calling sequence:
PSINE (XJ,DIN)

Contained in module: SINT

Called by: SINT

Calls: NONE

Input arguments:

XJ	R*8	100 times the argument of the sine function.
DIN	R*8	Difference between the arguments of the two sine functions.

Output arguments:

PSINE	R*4	The product sin(.01 * XJ) * sin(.01 * DIN).

9.21 PWRSPC

Subprogram name: Function PWRSPC

Purpose: Power spectrum at F for cascade of receiver-interferer filters.

Calling sequence:
PWRSPC (F)

Contained in module: ROTAC

Called by: RJCFCN

Calls: TPSPEC, TPSPJ

Input arguments:

F	R*4	Normalized frequency.

Output arguments:

PWRSPC	R*4	Power spectrum at F for cascade of receiver-interferer filters.

Global variables input from common:

```
FCRX           /BUTPAR/       R*4     BUTPAR.INC
               Normalized 3dB cut-off frequency of receiver filter.
FJSEPN         /JAMPAR/       R*4     JAMPAR.INC
               Normalized frequency separation between the
               interference signal and the desired signal.
IFILRX         /BUTPAR/       I*2     BUTPAR.INC
               Receiver filter indicator.
                       0 = MD-918 receiver filter.  Also means
                           filter is a Butterworth cascaded with a
                           rectangular impulse response filter of
                           duration equal to symbol duration.
                       1 = (not allowed)
                       2 = AN/TRC-170 receiver filter.  Also means
                           filter is a Butterworth.
NPOLRX         /BUTPAR/       R*4     BUTPAR.INC
               Number of poles in the receive Butterworth filter.
```

9.22 RJCFCN

Subprogram name: Function RJCFCN

Purpose: Calculate receiver-interferer correlation function by direct Fourier transform. PWRSUM is calculated as base value for FJSEPN = 0.0 Numerically integrate product of power spectrum, PWRSPC(FREQ), and COS(TWOPI * FREQ * TARG) over frequency interval [0.0, 10.0*FCRX].

Calling sequence:
RJCFCN (TARG,INIT)

Contained in module: BOTAC

Called by: BOTAC

Calls: PWRSPC, TPSPEC

Input arguments:

TARG	R*4	Normalized time argument.
INIT	I*2	Flag to perform initializations and to calculate normalization constant, PWRSUM, during first function call to RJCFCN for each interferer angle.

Output arguments:

RJCFCN	R*4	Receiver-interferer correlation function.
INIT	I*2	Flag to perform initializations and to calculate normalization constant, PWRSUM, during first function call to RJCFCN for each interferer angle.

Global variables input from common:

FCRX	/BUTPAR/	R*4	BUTPAR.INC
	Normalized 3dB cut-off frequency of receiver filter.		
TWOPI	/CONSTA/	R*4	CONSTANTS.INC
	2 X Pi = 6.283185307.		

Global variables output to common:

FJSEPN	/JAMPAR/	R*4	JAMPAR.INC
	Normalized frequency separation between the interference signal and the desired signal.		

9.23 SASEQ

Subprogram name: Subroutine SASEQ

Purpose: To set the chip sequence ASEQ as a function of the number of chips per thermal bit KGAIN.

Calling sequence:
CALL SASEQ (ASEQ)

Contained in module: SASEQ

Called by: MDTS TRCIN

Calls: NONE

Input arguments:
NONE

Output arguments:
ASEQ(30) I*2 Chip sequence for bandwidth spreading.

Global variables input from common:

KGAIN	/RZ/	I*2	RZ.INC
	Integer ratio of bandwidth to data rate.		
LOUT	/LUNS/	I*2	LUNS.INC
	FOR002.DAT output unit number.		

9.24 SIGIN

Subprogram name: Subroutine SIGIN

Purpose: Set pulse shape switch PULSE, number of taps K, lower and upper delay spread ratios SIGMA and SIGM1, number of future ISI considered LISI, and the proportionality constant SPOWR.

Calling sequence:

```
CALL SIGIN (K,SIGMA,SIGM1,TAU22,TAU23,SPOWR)
```

Contained in module: SIGIN

Called by: MDTS

Calls: NONE

Input arguments:

TAU22	R*8	Delay spread in lower beam in nanoseconds.
TAU23	R*8	Delay spread in upper beam in nanoseconds.

Output arguments:

K	I*2	Number of taps in either side of AFE center tap.
SIGMA	R*4	Ratio of lower beam delay spread to symbol duration.
SIGM1	R*4	Ratio of upper beam delay spread to symbol duration.
SPOWR	R*4	Proportionality constant used in ISI calculation.

Global variables input from common:

DRATE /MCOM4/ R*4 MCOM.INC
Data rate in bits/second. Default is 6.6E6.

IBW /MCOM2/ I*2 MCOM.INC
Switch indicating type of RF bandwidth constraint to be used on desired signal. Default is 0.
- 0 = No RF filtering
- 1 = Filter determined from 99% bandwidth constraint
- 2 = Filter chosen to meet FCC Mask. (FCC-19311)
- 3 = Filters are user specified

ICORR /MCOM2/ I*2 MCOM.INC
Multipath profile correlation indicator. Default is 2.
- 0 = Profile of the form X * exp(-A*X) -- used for debugging
- 1 = Computed multipath profile; no beam correlation
- 2 = Computed multipath profile; beam correlation.

KGAIN /RZ/ I*2 RZ.INC
Integer ratio of bandwidth to data rate.

LERR /LUNS/ I*2 LUNS.INC
Error output unit.

NTAP /MCOM2/ I*2 MCOM.INC
Number of adaptive forward equalizer taps (AFE) in

```
                    MD-918 modem.  Set to 3 in INDATA.

Global variables output to common:
    LISI            /MCOM2/        I*2     MCOM.INC
                    Number of future Intersymbol Interference (ISI)
                    contributors considered in MD-918 performance
                    calculation.  Default is 2.
    PULSE           /RZ/           I*2     RZ.INC
                    Switch controlling MD-918 pulse shape after
                    transmitter-receiver filtering.
                          PULSE = 0   Triangle
                                = 1   OQPSK matched filter
                                = 2   Sinc pulse, bandwidth equal to 1
                                = 5   RF filtering included
                    Set to 0 if IBW = 0 or KGAIN > 1.
                    Set to 5 if IBW > 0 and KGAIN = 1.
    TAPW            /MCOM4/        R*4     MCOM.INC
                    Normalized tapwidth for MD-918.  Default is .5.
                    Range is 0.25 through 1.0
```

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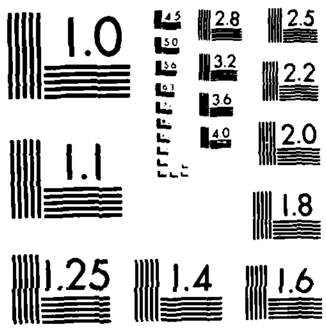

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9.25 SINC

Subprogram name: Function SINC

Purpose: SINC = SIN(PI*X) / (PI*X). For X = 0 or
ABS (Numerator - Denominator) < 1.0E-6 SINC = 1.

Calling sequence:
SINC (X)

Contained in module: SINC

Called by: CAC, FILSIX, TSINC

Calls: NONE

Input arguments:

X	R*4	Argument of SINC function.

Output arguments:

SINC	R*4	Value of SIN(PI*X) / PI*X.

Global variables input from common:

PI	/CONSTA/	R*4	CONSTANTS.INC
	Constant Pi = 3.141592654.		

9.26 SQTMAT

Subprogram name: Subroutine SQTMAT

Purpose: Subroutine to take square root of a symmetric, positive-definite matrix D of order < = 7 by computing:

SQRT(D) = (EMODAL) * SQRT(UNITRY) * (TRANSP(EMODAL)).

Where EMODAL is the matrix containing the eigenvectors of D (the 'modal' matrix) and UNITRY is the matrix containing the eigenvalues of D in its diagonal (the 'unitary' matrix).

Calling sequence:

```
CALL SQTMAT (D,SQRTD,K1)
```

Contained in module: MATOPS

Called by: MDTS

Calls: CHANGE, EIGEN, ERROR, MATA

Input arguments:

D(K1,K1)	R*4	Original matrix: real, symmetric, undisturbed. Dimensioned as 7 X 7.
K1	I*2	Dimensions of matrix D. Maximum is 7.

Output arguments:

SQRTD	R*4	Square root matrix.

9.27 TPSPEC

Subprogram name: Function TPSPEC

Purpose: Power spectrum at F for Butterworth * IFILT-type filter.

Calling sequence:

```
TPSPEC (F,NPOLE,FCUT,IFILT)
```

Contained in module: BOTAC

Called by: PWRSPC, TPSPJ

Calls: NONE

Input arguments:

F	R*4	Normalized frequency.
NPOLE	R*4	Number of poles of Butterworth filter.
FCUT	R*4	Normalized 3-dB cut-off frequency of Butterworth filter.
IFILT	I*2	Switch that indicates whether rectangular impulse response filter is cascaded with Butterworth filter (= 0,1) or not (= 2).

Output arguments:

TPSPEC	R*4	Power spectrum for Butterworth * IFILT-type filter.

Global variables input from common:

PI	/CONSTA/	R*4	CONSTANTS.INC
	Constant Pi = 3.141592654.		

9.28 TPSPJ

Subprogram name: Function TPSPJ

Purpose: Power spectrum of interferer at frequency F.

Calling sequence:
TPSPJ (F)

Contained in module: BOTAC

Called by: PWRSPC

Calls: TPSPEC

Input arguments:
F R*4 Normalized frequency.

Output arguments:
TPSPJ R*4 Power spectrum of interferer at frequency F.

Global variables input from common:

```
     FCJ            /JAMPAR/      R*4    JAMPAR.INC
                    Normalized 3dB cut-off frequency of QPSK interference
                    filter.
     FCTX           /BUTPAR/      R*4    BUTPAR.INC
                    Normalized 3dB cut-off frequency of transmitter
                    filter.
     FMI            /JAMPAR/      R*4    JAMPAR.INC
                    Modulation index for FDM/FM interference.
     IFILTX         /BUTPAR/      I*2    BUTPAR.INC
                    Transmitter filter indicator.
                            0 = MD-918 transmitter filter.  Also means
                                filter is a Butterworth cascaded with a
                                rectangular impulse response filter of
                                duration equal to symbol duration.
                            1 = AN/TRC-170 transmitter filter.  Also means
                                filter is a cascade of Butterworth filter
                                with rectangular impulse response filter
                                of duration equal to half symbol duration.
                            2 = (not allowed)
     MODSG          /JAMPAR/      I*2    JAMPAR.INC
                    Interference signal modulation format.  Default is 1.
                            0 = Analog FDM / FM
                            1 = Digital QPSK
     NPOLJ          /JAMPAR/      I*2    JAMPAR.INC
                    Number of poles in the QPSK interference filter.
     NPOLTX         /BUTPAR/      I*2    BUTPAR.INC
                    Number of poles in the transmit Butterworth filter.
     PI             /CONSTA/      R*4    CONSTANTS.INC
```

	Constant Pi = 3.141592654.		
WFM	/JAMPAR/	R*4	JAMPAR.INC
	Normalization constant for FDM/FM interference.		

9.29 TSINC

Subprogram name: Function TSINC

Purpose: TSINC = B * convolution of triangular impulse response filter and waveform with impulse response sinc(B*X) evaluated at the point X.

Calling sequence:
TSINC (B,X)

Contained in module: BOTAC

Called by: BOTAC, JAMCOM

Calls: SINC

Input arguments:

B	R*8	Normalized bandwidth of SINC waveform.
X	R*8	Normalized time argument.

Output arguments:

TSINC	R*4	Convolution.

9.30 XNOR

Subprogram name: Function XNOR

Purpose: Gaussian PDF with mean SPA and standard deviation SPS. Note, the arguments are single precision though the output is double.

Calling sequence:
XNOR (SPX,SPA,SPS)

Contained in module: XNOR

Called by: BERCAL, MDTS, TRC

Calls: NONE

Input arguments:

SPX	R*4	Value of Gaussian random variable at which PDF is to be calculated.
SPA	R*4	Mean of distribution.
SPS	R*4	Standard deviation of distribution,

Output arguments:

XNOR	R*8	Gaussian PDF.

CHAPTER 10

AN/TRC-170 MODEM CALCULATIONS

This section describes the AN/TRC-170-DAR modem performance calculation routines:

Name	Description	User's Manual section
AVG	Short-term ABER and outage probabilities	2.9.5
EIGV	Implicit diversity eigenvalues	2.9.4
INTERD	Linear interpolation	NA
P2INT	Correlation of response with itself	2.9.4
PAVERG	Conditional aberage bit error probability	2.9.5
PDF	PDF of detection SNR	2.9.4
PDFCOE	PDF coefficients	2.9.4
PDFSUM	PDF integration of SNR	NA
POUTAG	Conditional outage probability	2.9.5
PROFIL	Power/delay profile	2.9.4
TIMAVG	Short-term ABER and outage probability	2.9.5
TIMEQL	Sampling times	2.9.3
TIMPAR	Steady state sampling time . .	NA
TRC	Main TRC routine	2.9.1, 2.9.2
TRCIN	TRC parameters	2.9.1, 2.9.4
TXPULS	Tx-Rx impulse response	2.9.4
VARW	ISI variance	2.9.5

The main routine for this section is TRC. The TRC modem performance calculations are described in section 2.9 of the User's Manual.

Figure 2-6 is a top level flowchart for AN/TRC-170-DAR modem performance calculations at a functional level. In most cases the blocks correspond to one or more subprograms. The test blocks (diamonds) correspond to logical branches which are decided by the user's choices of input data.

NOTE

In most cases the sections in the User's Manual describe the coded equations as well as the theory behind them. NA denotes routines that are programming utilities such as finding indices, setting pointers, etc.

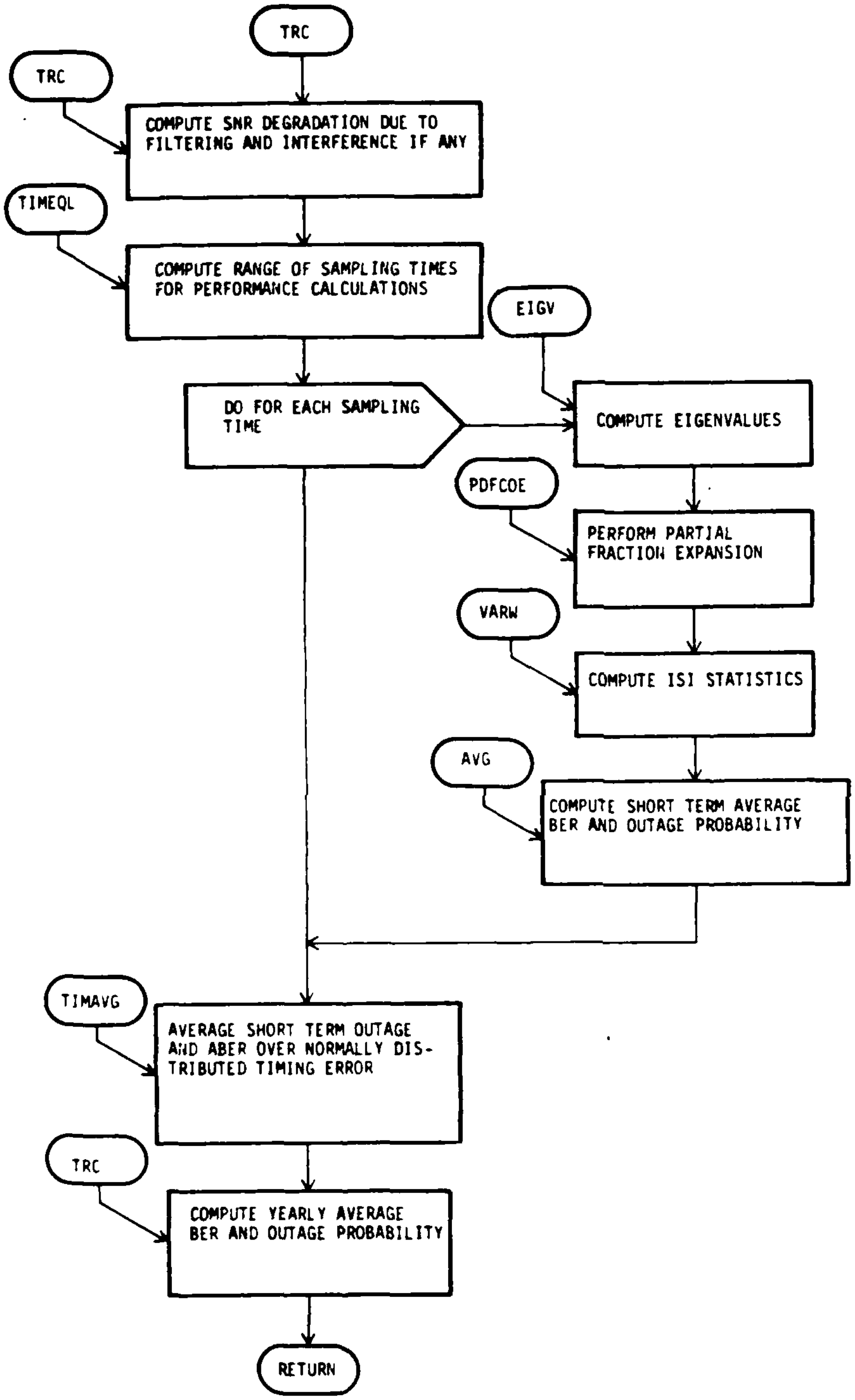

Figure 2-6 Flow Chart for AN/TRC-170-DAR Modem Performance Calculations

10.1 AVG

Subprogram name: Subroutine AVG

Purpose: To calculate short-term average bit error rate and short-term outage probability of AN/TRC-170 given the short term average SNR per bit by integrating over the statistics of the instantaneous detection SNR of the modem.

Calling sequence:
CALL AVG (YRUTIN, Y, IERR)

Contained in module: TRC

Called by: TRC

Calls: PDF, YRUTIN

Input arguments:

YRUTIN	R*4	Function name. May be PAVERG or POUTAG.

Output arguments:

Y	R*4	Twice the average bit error rate if the function requested is PAVERG and outage probability if the function requested is POUTAG.
IERR	I*2	Error flag.

Global variables input from common:

COEFF	/ANSWER/	R*8	ANSWER.INC
	Partial fraction expansion coefficients for calculation of AN/TRC-170 outage probability.		
NDIVS	/SYSPAR/	I*2	SYSPAR.INC
	Number of explicit diversity channels for AN/TRC-170. Equal to 4 for 2S/2F and 2 for 2S or 2F.		
NEIGEN	/ANSWER/	I*2	ANSWER.INC
	Number of implicit diversity eigenvalues (stored in array VEIGV) used in calculation of AN/TRC-170 performance.		
VEIGV(20)	/ANSWER/	R*8	ANSWER.INC
	Implicit diversity eigenvalues for AN/TRC-170.		
X3INCR	/NUMPAR/	R*4	NUMPAR.INC
	Step increment for numerical integration.		

10.2 EIGV

Subprogram name: Subroutine EIGV

Purpose: Calculates the implicit diversity eigenvalues of the AN/TRC-170.

Calling sequence:
CALL EIGV (X2INCR, NV, EIGMIN, IERR)

Contained in module: TRC

Called by: TRC

Calls: ELMES, HQR, ORDER, PROFIL, TXPULS

Input arguments:

X2INCR	R*4	Step increment for numerical integration.
NV	I*2	Number of eigenvalues to be computed.
EIGMIN	R*4	Ratio of smallest to largest eigenvalue of interest.

Output arguments:

IERR	I*2	Error flag.

Global variables input from common:

IPROFL /SYSPAR/ I*2 SYSPAR.INC
Parameter that indicates whether troposcatter power per unit delay profile of the form X exp (-A*X) is to be used (IPROFL = 0) or not. Set to zero in TRCIN.

SIGMA /SYSPAR/ R*4 SYSPAR.INC
Half the RMS lower beam delay spread normalized relative to the symbol duration.

TO /SYSPAR/ R*4 SYSPAR.INC
Normalized sampling time for lower beam.

Global variables output to common:

DIVIMP /ANSWER/ R*4 ANSWER.INC
Ratio of square of mean signal energy to variance for AN/TRC-170.

ENMEAN /ANSWER/ R*4 ANSWER.INC
Average received energy.

ENVAR /ANSWER/ R*4 ANSWER.INC
Variance of received energy.

NEIGEN /ANSWER/ I*2 ANSWER.INC
Number of implicit diversity eigenvalues (stored in array VEIGV) used in calculation of AN/TRC-170 performance.

VEIGV(20) /ANSWER/ R*8 ANSWER.INC
Implicit diversity eigenvalues for AN/TRC-170.

10.14 TRC

Subprogram name: Subroutine TRC

Purpose: To calculate the short-term BER and outage probability of the AN/TRC-170 or DAR modem as a function of SNR for the specified diversity configuration and BER threshold and the yearly outage probability given the yearly median of the troposcatter signal SNR and its standard deviation.

Calling sequence:

```
CALL TRC (TRCTYP,IBW,PYEAR)
```

Contained in module: TRC

Called by: TRCIN

Calls: AVG, EIGV, PAVERG, PDFCOE, PDFSUM, POUTAG, TIMAVG, TIMEQL, TIMPAR, VARW, XNOR

Input arguments:

TRCTYP	R*4	TRC-170 modem type indicator: 0 = 1 frequency DAR modem 1 = 2 frequency AN/TRC-170 modem
IBW	I*2	Switch indicating which type of RF bandwidth constraint to be used on desired signal. 0 = No RF filtering 1 = Filter determined from 99% bandwidth constraint 2 = Filter chosen to meet FCC Mask. (FCC-19311) 3 = Filters are user specified.

Output arguments:

PYEAR(2,3)	R*4	Yearly statistics. PYEAR(1,.) is yearly outage probability and PYEAR(2,.) is yearly fade outage probability per call minute for each BER threshold.

Global variables input from common:

ASNR	/SYSPAR/	R*4	SYSPAR.INC
	Yearly median value of troposcatter short-term average SNR, ie, Eb/No, in dB.		
CDUR	/SYSPAR/	R*4	SYSPAR.INC
	Duration of transmitted pulse for AN/TRC-170 normalized to signaling interval duration.		
COEFF	/ANSWER/	R*8	ANSWER.INC
	Partial fraction expansion coefficients for calculation of AN/TRC-170 outage probability.		
EIGMIN	/NUMPAR/	R*4	NUMPAR.INC

10.13 TIMPAR

Subprogram name: Function TIMPAR

Purpose: To calculate sampling time at steady state from early-late gate loop.

Calling sequence:
TIMPAR (X2INCR,XINCR)

Contained in module: TRC

Called by: TIMEQL, TRC

Calls: PROFIL, P2INT

Input arguments:

X2INCR	R*4	Step increment for numerical integration.
XINCR	R*4	Step increment for numerical integration.

Output arguments:

TIMPAR	R*4	Sampling time at steady state from early-late gate loop.

Global variables input from common:

IPROFL	/SYSPAR/	I*2	SYSPAR.INC
	Parameter that indicates whether troposcatter power per unit delay profile of the form X exp (-A*X) is to be used (IPROFL = 0) or not. Set to zero in TRCIN.		
SIGMA	/SYSPAR/	R*4	SYSPAR.INC
	Half the RMS lower beam delay spread normalized relative to the symbol duration.		
TO	/SYSPAR/	R*4	SYSPAR.INC
	Normalized sampling time for lower beam.		

10.12 TIMEQL

Subprogram name: Subroutine TIMEQL

Purpose: To determine the various sampling times for the short-term performance of the AN/TRC-170.

Calling sequence:
CALL TIMEQL (TOTO, IT, TPAR, TDEV, X2INCR, XINCR, IERR)

Contained in module: TRC

Called by: TRC

Calls: TIMPAR

Input arguments:

TDEV	R*4	Standard deviation of sampling time.
X2INCR	R*4	Step increment for numerical integration.
XINCR	R*4	Step increment for numerical integration.

Output arguments:

TOTO(20)	R*4	Array of sampling times (normalized to symbol duration) for calculation of short term TRC-170 performance.
IT	I*2	Number of different sampling times to be used in calculation of TRC-170 short term performance.
TPAR(20)	R*4	Sampling times at steady-state for early-late gate loop.
IERR	I*2	Error flag.

Global variables output to common:

TO	/SYSPAR/	R*4	SYSPAR.INC
	Normalized sampling time for lower beam.		

10.11 TIMAVG

Subprogram name: Subroutine TIMAVG

Purpose: To average the short-term average bit error rate and short-term outage probability over Gaussian distributed timing jitter.

Calling sequence:
CALL TIMAVG (PERF, TOTO, IT, TDEV, PERAVG, IERR)

Contained in module: TRC

Called by: TRC

Calls: INTERD

Input arguments:

PERF(20)	R*4	Performance measure for each sampling time.
TOTO(20)	R*4	Array of sampling times (normalized to symbol duration) for calculation of short term TRC-170 performance.
IT	I*2	Number of different sampling times to be used in calculation of TRC-170 short term performance.
TDEV	R*4	Standard deviation of timing jitter.

Output arguments:

PERAVG	R*4	Average of performance measure over Gaussian distributed timing jitter.
IERR	I*2	Error flag: 0 = no error; 1 = error in performance measure calculation.

10.10 PROFIL

Subprogram name: Function PROFIL

Purpose: To calculate the power per unit delay profile of received troposcatter signal. Presently only an exponential profile of the form A*X * EXP(-B*X) is allowed. Power per unit delay profiles calculated in propagation module may be added later.

Calling sequence:
PROFIL (X, IPROFL, SIGMA)

Contained in module: TRC

Called by: EIGV, TIMPAR, VARW

Calls: NONE

Input arguments:

X	R*4	Normalized delay at which profile is to be sampled.
IPROFL	I*2	Switch: 0 = exponential power per unit delay profile to be used.
SIGMA	R*4	Lower beam normalized delay spread.

Output arguments:

PROFIL	R*4	Power per unit delay profile.

Standard deviation of future ISl for AN/TRC-170.

10.9 POUTAG

Subprogram name: Subroutine POUTAG

Purpose: Calculates the conditional outage probability for a given instantaneous SNR by averaging over ISI due to up to two past and two future symbols.

Calling sequence:
CALL POUTAG (X, OUTISI, IERR)

Contained in module: TRC

Called by: TRC

Calls: ERFC, INTERD

Input arguments:

X	R*4	Instantanous detection SNR.

Output arguments:

OUTISI	R*4	Conditional outage probability.
IERR	I*2	Error flag.

Global variables input from common:

IRSN	/NUMPAR/	I*2	NUMPAR.INC
	Number of values in SNR array RSNRSN(30). Used to calculate ISI statistics for AN/TRC-170. Initially set to 30.		
KISI	/NUMPAR/	I*2	NUMPAR.INC
	Parameter for calculation of AN/TRC-170 outage probability. Set to 6 in data statement.		
NTHR	/SYSPAR/	I*2	SYSPAR.INC
	Pointer to bit error rate threshold for AN/TRC-170 outage probability calculation.		
RSNMIN(3)	/NUMPAR/	R*4	NUMPAR.INC
	SNR threshold corresponding to each bit error rate threshold for AN/TRC-170.		
RSNRSN(30)	/NUMPAR/	R*4	NUMPAR.INC
	Set of SNR values for which solution of transcendental function (UPISIM) is tabulated.		
SNR	/SYSPAR/	R*4	SYSPAR.INC
	Signal to noise ratio.		
UPISIM(30,3)	/NUMPAR/	R*4	NUMPAR.INC
	Solution of transcendental equation for each value of RSNRSN and bit error rate threshold of interest in AN/TRC-170 outage probability calculation.		
XAVAR	/ANSWER/	R*4	ANSWER.INC
	Standard deviation of past ISI for AN/TRC-170.		
XBVAR	/ANSWER/	R*4	ANSWER.INC

10.8 PDFSUM

Subprogram name: Function PDFSUM

Purpose: Integration of the probability density function of the detection SNR.

Calling sequence:
PDFSUM (NDIVS, NEIGEN, VEIGV, COEFF, XINCR)

Contained in module: TRC

Called by: TRC

Calls: ERLANG, PDF

Input arguments:

NDIVS	I*2	Number of explicit diversities.
NEIGEN	I*2	Number of eigenvalues in array VEIGV. Maximum is 20.
VEIGV(NEIGEN)	R*8	Implicit diversity eigenvalues for AN/TRC-170. Dimensioned to 20.
COEFF(40)	R*8	Partial fraction expansion coefficients.
XINCR	R*4	Step increment for numerical integration.

Output arguments:

PDFSUM	R*4	Integration of the probability density function of the detection SNR.

10.7 PDFCOE

Subprogram name: Subroutine PDFCOE

Purpose: Find partial fraction expansion coefficients of signal gain distribution. C((N-1)*ID + I), of

```
F(s) = (R(1) / (S + R(1)))**ID  * ... *  (R(NU) / (S + R(NU)))**ID
F(s) =  ...C((N - 1) * ID + I) / (S + R(N)) * ID - I + 1 ...
for N = 1,2,...NU; I = 1,2,...ID
```

Calling sequence:

```
CALL PDFCOE (NR, R, NDIVS, C, IERR)
```

Contained in module: TRC

Called by: TRC

Calls: NONE

Input arguments:

R(NR)	R*8	Input root array. R(K) > 0, K = 1,NR. Dimensioned to 20.
NR	I*2	Size of R array. Maximum is 20. Also NR X NDIVS must be less than or equal to 40.
NDIVS	I*2	Number of explicit diversity branches. Value must be such that NR X NDIVS is less than or equal to 40.

Output arguments:

C(NR*NDIVS)	R*8	Partial fraction expansion coefficients. Dimensioned to 40.
IERR	I*2	Error flag.

10.6 PDF

Subprogram name: Function PDF

Purpose: Computes the probability density function of the detection SNR for the AN/TRC-170.

Calling sequence:

```
PDF (X, NEIGEN, NDIVS, VEIGV, COEFF)
```

Contained in module: TRC

Called by: AVG, PDFSUM

Calls: ERLANG

Input arguments:

X	R*4	SNR at which PDF is to be evaluated.
NEIGEN	I*2	Number of eigenvalues in array VEIGV. Maximum is 20.
NDIVS	I*2	Number of explicit diversities.
VEIGV(NEIGEN)	R*8	Implicit diversity eigenvalues for AN/TRC-170. Dimensioned to 20.
COEFF(40)	R*8	Partial fraction expansion coefficients.

Output arguments:

PDF	R*4	Probability density function of the detection SNR for the AN/TRC-170.

10.5 PAVERG

Subprogram name: Subroutine PAVERG

Purpose: To calculate twice the instantaneous bit error rate (or conditional bit error rate) of the AN/TRC-170 given the instantaneous detection SNR and variance of the ISI.

Calling sequence:
CALL PAVERG (X, AVGISI, IERR)

Contained in module: TRC

Called by: TRC

Calls: ERFC

Input arguments:

X	R*4	Instantaneous detection SNR.

Output arguments:

AVGISI	R*4	Twice the instantaneous bit error rate.
IERR	I*2	Error flag

Global variables input from common:

SNR	/SYSPAR/	R*4	SYSPAR.INC
	Signal to noise ratio.		
VARISI	/ANSWER/	R*4	ANSWER.INC
	Total ISI variance for AN/TRC-170.		

10.4 P2INT

Subprogram name: Function P2INT

Purpose: Correlates the transmitter-receiver filter impulse response with a delayed version of itself.

Calling sequence:
P2INT (A, B, XL, XU, XINCR)

Contained in module: TRC

Called by: TIMPAR, VARW

Calls: TXPULS

Input arguments:

A	R*4	Sampling time at the output of the receiver filter.
B	R*4	Delay between correlator inputs.
XL	R*4	Lower integration limit.
XU	R*4	Upper integration limit.
XINCR	R*4	Step increment for numerical integration.

Output arguments:

P2INT	R*4	Correlation of the transmitter-receiver filter impulse response with a delayed version of itself.

Global variables input from common:

IPULS /SYSPAR/ I*2 SYSPAR.INC
Switch to indicate whether pulse shape at input of the AN/TRC-170 detector includes the effects of RF filters (IPULS = 2) or not (IPULS = 0 or 1). Set to 2 internally. If IBW is 0, set to 1.

NCHIP /SYSPAR/ I*2 SYSPAR.INC
Number of chips in PN sequence used to expand bandwidth in AN/TRC-170.

PDUR /SYSPAR/ R*4 SYSPAR.INC
Symbol pulse duration.

10.3 INTERD

Subprogram name: Subroutine INTERD

Purpose: Linear interpolation in a table of N pairs (XX,YY).

Calling sequence:
CALL INTERD (Y, X, YY, XX, N, IERR)

Contained in module: TRC

Called by: POUTAG, TIMAVG

Calls: NONE

Input arguments:

X	R*4	Value of x-coordinate for which y-coordinate is desired.
YY(N)	R*4	Tabulated values of y-coordinate corresponding to tabulated x-coordinate. Dimensioned to 30.
XX(N)	R*4	Tabulated values of x-coordinate corresponding to tabulated y-coordinate. Dimensioned to 30.
N	I*2	Number of tabulated values over which interpolation is to be performed. Maximum is 30.

Output arguments:

Y	R*4	Value of y-coordinate corresponding to X.
IERR	I*2	Error flag. 0 = no error 5 = x-coordinate value greater than largest tabulated value 6 = x-coordinate value less than smallest tabulated value

	Ratio of smallest to largest eigenvalue in AN/TRC-170 performance calculations.		
ENMEAN	/ANSWER/	R*4	ANSWER.INC
	Average received energy.		
ICHIP(30)	/SYSPAR/	I*2	SYSPAR.INC
	PN sequence for spectrum spreading when the data rate is much smaller than the bandwidth.		
IOPERF	/IOUT/	I*2	IOUT.INC
	Switch for calculation of performance of AN/TRC-170. 0 = ABER and outage probability 1 = ABER (average bit error rate) only 2 = Outage probability only Set to 0 internally.		
IOTIME	/IOUT/	I*2	IOUT.INC
	Switch for calculation of performance of AN/TRC-170. 0 = Short term performance assuming various sampling times. 1 = Short term performance assuming Gaussian timing jitter. 2 = Yearly average performance assuming Gaussian timing jitter. Set to 2 internally.		
IPROFL	/SYSPAR/	I*2	SYSPAR.INC
	Parameter that indicates whether troposcatter power per unit delay profile of the form X exp (-A*X) is to be used (IPROFL = 0) or not. Set to zero in TRCIN.		
IPULS	/SYSPAR/	I*2	SYSPAR.INC
	Switch to indicate whether pulse shape at input of the AN/TRC-170 detector includes the effects of RF filters (IPULS = 2) or not (IPULS = 0 or 1). Set to 2 internally. If IBW is 0, set to 1.		
ISN	/IOUT/	I*2	IOUT.INC
	Number of SNR values for which short-term performance of AN/TRC-170 is to be performed. Set to 17.		
IT	/IOUT/	I*2	IOUT.INC
	Number of different sampling times to be used in calculation of AN/TRC-170 short term performance.		
KISI	/NUMPAR/	I*2	NUMPAR.INC
	Parameter for calculation of AN/TRC-170 outage probability. Set to 6 in data statement.		
LERR	/LUNS/	I*2	LUNS.INC
	Error output unit.		
LOUT	/LUNS/	I*2	LUNS.INC
	FOR002.DAT output unit number.		
NCHIP	/SYSPAR/	I*2	SYSPAR.INC
	Number of chips in PN sequence used to expand bandwidth in AN/TRC-170.		
NDIVS	/SYSPAR/	I*2	SYSPAR.INC
	Number of explicit diversity channels for AN/TRC-170. Equal to 4 for 2S/2F and 2 for 2S or 2F.		

NEIGEN	/ANSWER/	I*2	ANSWER.INC	
	Number of implicit diversity eigenvalues (stored in array VEIGV) used in calculation of AN/TRC-170 performance.			
NPOINT	/NUMPAR/	I*2	NUMPAR.INC	
	Number of points for numerical integration.			
NTH1	/IOUT/	I*2	IOUT.INC	
	Pointer to largest bit error rate threshold of interest for AN/TRC-170 outage probability calculation.			
NTH2	/IOUT/	I*2	IOUT.INC	
	Pointer to smallest bit error rate threshold of interest for AN/TRC-170 outage probability calculation.			
NTHR	/SYSPAR/	I*2	SYSPAR.INC	
	Pointer to bit error rate threshold for AN/TRC-170 outage probability calculation.			
NV	/NUMPAR/	I*2	NUMPAR.INC	
	Normalization parameter for calculation of AN/TRC-170 signal gain. Set to 18.			
PEAKAV	/RZ4/	R*4	RZ4.INC	
	Peak-to-average loss due to RF filtering in dB.			
SIGMA	/SYSPAR/	R*4	SYSPAR.INC	
	Half the RMS lower beam delay spread normalized relative to the symbol duration.			
SNDB(2)	/IOUT/	R*4	IOUT.INC	
	Signal to noise ratio in dB.			
SNRBW	/RZ4/	R*4	RZ4.INC	
	Signal to noise ratio adjustment for AN/TRC-170 due to limited receive filter bandwidth.			
SNRF2	/RZ4/	R*4	RZ4.INC	
	Parameter to adjust the signal to noise ratio for degradation due to interference from another frequency. Only for 2-frequency AN/TRC-170 modem.			
SNRJAM	/RZ4/	R*4	RZ4.INC	
	Parameter to adjust the signal to noise ratio of AN/TRC-170 for degradation due to colocated/adjacent channel interference.			
STSNR1	/SYSPAR/	R*4	SYSPAR.INC	
	Standard deviation of troposcatter signal long-term SNR distribution in dB. Same as STSNR in /SUMP/.			
TOTO(20)	/IOUT/	R*4	IOUT.INC	
	Array of sampling times (normalized to symbol duration) for calculation of short term AN/TRC-170 performance.			
TDEV	/NUMPAR/	R*4	NUMPAR.INC	
	Standard deviation of sampling times for AN/TRC-170 performance calculations.			

Global variables output to common:

PAVG(20,20)	/ANSWER/	R*4	ANSWER.INC	
	Short-term average bit error rate for each sampling time and short-term average SNR.			
PDUR	/SYSPAR/	R*4	SYSPAR.INC	
	Symbol pulse duration.			
POUT(20,20,3)	/ANSWER/	R*4	ANSWER.INC	
	AN/TRC-170 outage probability and average bit error rate as a function of sampling time, short-term average SNR and error rate threshold.			
SNR	/SYSPAR/	R*4	SYSPAR.INC	
	Signal to noise ratio.			
TO	/SYSPAR/	R*4	SYSPAR.INC	
	Normalized sampling time for lower beam.			
TPAR(20)	/ANSWER/	R*4	ANSWER.INC	
	Timing parameter for AN/TRC-170. Calculated when IOTIME is 0.			
VARAIS	/ANSWER/	R*4	ANSWER.INC	
	Past ISI variance for AN/TRC-170.			
VARBIS	/ANSWER/	R*4	ANSWER.INC	
	Future ISI variance for AN/TRC-170.			
VARISI	/ANSWER/	R*4	ANSWER.INC	
	Total ISI variance for AN/TRC-170.			
VEIGV(20)	/ANSWER/	R*8	ANSWER.INC	
	Implicit diversity eigenvalues for AN/TRC-170.			
X2INCR	/NUMPAR/	R*4	NUMPAR.INC	
	Step increment for numerical integration.			
XAVAR	/ANSWER/	R*4	ANSWER.INC	
	Standard deviation of past ISI for AN/TRC-170.			
XBVAR	/ANSWER/	R*4	ANSWER.INC	
	Standard deviation of future ISI for AN/TRC-170.			
XINCR	/NUMPAR/	R*4	NUMPAR.INC	
	Step increment for numerical integration.			

10.15 TRCIN

Subprogram name: Subroutine TRCIN

Purpose: To define parameters for calculation of the AN/TRC-170 or DAR modem troposcatter performance for the data rate and bandwidth specified by the user.

Calling sequence:

```
CALL TRCIN (TRCTYP,BW,IBW,TAU22,DRATE,ASNR1,DSTSNR,NERT, BOUT,FOUT)
```

Contained in module: TRC

Called by: TROPO

Calls: ERROR SASEQ TRC

Input arguments:

TRCTYP	R*4	TRC-170 modem type indicator: 0 = 1 frequency DAR modem 1 = 2 frequency AN/TRC-170 modem
BW	R*4	Bandwidth in Hz.
IBW	I*2	Switch indicating which type of RF bandwidth constraint to be used on desired signal. 0 = No RF filtering 1 = Filter determined from 99% bandwidth constraint 2 = Filter chosen to meet FCC Mask. (FCC-19311) 3 = Filters are user specified.
TAU22	R*8	Delay spread on lower beam in nsec.
DRATE	R*4	Data rate in bits per seconds.
ASNR1	R*4	Median and/or yearly average value of troposcatter signal SNR in dB.
DSTSNR	R*4	Standard deviation of troposcatter signal long-term SNR distribution in dB.
NERT	I*2	Bit error rate threshold indicator for yearly outage probability calculations. 0 = All three thresholds 1 = For 10**(-3) only 2 = For 10**(-4) only 3 = For 10**(-5) only

Output arguments:

BOUT(3,4)	R*4	Yearly average outage probability for each bit error rate threshold specified and 2S/2F and 2S diversity configurations.
FOUT(3,4)	R*4	Yearly average fade outage per call minute for each bit error rate threshold specified and 2S/2F and 2S diversity configurations.

```
Global variables input from common:
     KGAIN          /RZ/            I*2     RZ.INC
                    Integer ratio of bandwidth to data rate.
     LOUT           /LUNS/          I*2     LUNS.INC
                    FOR002.DAT output unit number.
     NTHR           /SYSPAR/        I*2     SYSPAR.INC
                    Pointer to bit error rate threshold for AN/TRC-170
                    outage probability calculation.

Global variables output to common:
     ASNR           /SYSPAR/        R*4     SYSPAR.INC
                    Yearly median value of troposcatter short-term average
                    SNR, ie, Eb/No, in dB.
     CDUR           /SYSPAR/        R*4     SYSPAR.INC
                    Duration of transmitted pulse for AN/TRC-170
                    normalized to signaling interval duration.
     ICHIP(30)      /SYSPAR/        I*2     SYSPAR.INC
                    PN sequence for spectrum spreading when the data
                    rate is much smaller than the bandwidth.
     IOPERF         /IOUT/          I*2     IOUT.INC
                    Switch for calculation of performance of AN/TRC-170.
                            0 = ABER and outage probability
                            1 = ABER (average bit error rate) only
                            2 = Outage probability only
                    Set to 0 internally.
     IOTIME         /IOUT/          I*2     IOUT.INC
                    Switch for calculation of performance of AN/TRC-170.
                            0 = Short term performance assuming various
                                sampling times.
                            1 = Short term performance assuming Gaussian
                                timing jitter.
                            2 = Yearly average performance assuming
                                Gaussian timing jitter.
                    Set to 2 internally.
     IPROFL         /SYSPAR/        I*2     SYSPAR.INC
                    Parameter that indicates whether troposcatter power
                    per unit delay profile of the form X exp (-A*X) is to
                    be used (IPROFL = 0) or not.  Set to zero in TRCIN.
     IPULS          /SYSPAR/        I*2     SYSPAR.INC
                    Switch to indicate whether pulse shape at input of the
                    AN/TRC-170 detector includes the effects of RF filters
                    (IPULS = 2) or not (IPULS = 0 or 1).  Set to 2
                    internally.  If IBW is 0, set to 1.
     ISN            /IOUT/          I*2     IOUT.INC
                    Number of SNR values for which short-term performance
                    of AN/TRC-170 is to be performed.  Set to 17.
     NCHIP          /SYSPAR/        I*2     SYSPAR.INC
                    Number of chips in PN sequence used to expand
                    bandwidth in AN/TRC-170.
```

NDIVS	/SYSPAR/	I*2	SYSPAR.INC
	Number of explicit diversity channels for AN/TRC-170. Equal to 4 for 2S/2F and 2 for 2S or 2F.		
NTH1	/IOUT/	I*2	IOUT.INC
	Pointer to largest bit error rate threshold of interest for AN/TRC-170 outage probability calculation.		
NTH2	/IOUT/	I*2	IOUT.INC
	Pointer to smallest bit error rate threshold of interest for AN/TRC-170 outage probability calculation.		
PEAKAV	/RZ4/	R*4	RZ4.INC
	Peak-to-average loss due to RF filtering in dB.		
SIGMA	/SYSPAR/	R*4	SYSPAR.INC
	Half the RMS lower beam delay spread normalized relative to the symbol duration.		
SNDB(2)	/IOUT/	R*4	IOUT.INC
	Signal to noise ratio in dB.		
SNR	/SYSPAR/	R*4	SYSPAR.INC
	Signal to noise ratio.		
STSNR1	/SYSPAR/	R*4	SYSPAR.INC
	Standard deviation of troposcatter signal long-term SNR distribution in dB. Same as STSNR in /SUMP/.		

10.16 TXPULS

Subprogram name: Function TXPULS

Purpose: Calculates the impulse response of the cascade of transmitter and receiver filters at time X.

Calling sequence:
TXPULS (X)

Contained in module: TRC

Called by: EIGV, P2INT

Calls: NONE

Input arguments:

X	R*4	Normalized sampling time.

Output arguments:

TXPULS	R*4	Impulse response of the cascade of transmitter and receiver filters at time X.

Global variables input from common:

CDUR	/SYSPAR/	R*4	SYSPAR.INC
	Duration of transmitted pulse for AN/TRC-170 normalized to signaling interval duration.		
ICHIP(30)	/SYSPAR/	I*2	SYSPAR.INC
	PN sequence for spectrum spreading when the data rate is much smaller than the bandwidth.		
IPULS	/SYSPAR/	I*2	SYSPAR.INC
	Switch to indicate whether pulse shape at input of the AN/TRC-170 detector includes the effects of RF filters (IPULS = 2) or not (IPULS = 0 or 1). Set to 2 internally. If IBW is 0, set to 1.		
NCHIP	/SYSPAR/	I*2	SYSPAR.INC
	Number of chips in PN sequence used to expand bandwidth in AN/TRC-170.		
NTR	/RZ4/	I*2	RZ4.INC
	Number of samples for calculating transmit-receive filter impulse response (TRFILT).		
PDUR	/SYSPAR/	R*4	SYSPAR.INC
	Symbol pulse duration.		
TRFILT(128)	/RZ4/	R*4	RZ4.INC
	Transmit-receive filter impulse response.		
XTRO	/RZ4/	R*4	RZ4.INC
	Time origin for transmit-receive filter impulse response (TRFILT), ie, X is TRFILT(X+XTRO).		
XTRINC	/RZ4/	R*4	RZ4.INC
	Sample interval for calculation of transmit-receive		

filter impulse response (TRFILT).

10.17 VARW

Subprogram name: Function VARW

Purpose: Variance of the ISI due to the kth past or future symbol.

Calling sequence:
VARW (K,XINCR,X2INCR)

Contained in module: TRC

Called by: TRC

Calls: PROFIL, P2INT

Input arguments:

K	I*2	ISI symbol indicator: past if positive, future if negative.
XINCR	R*4	Step increment for numerical integration.
X2INCR	R*4	Step increment for numerical integration.

Output arguments:

VARW	R*4	Variance of the ISI due to the kth past or future symbol.

Global variables input from common:

IPROFL	/SYSPAR/	I*2	SYSPAR.INC
	Parameter that indicates whether troposcatter power per unit delay profile of the form X exp (-A*X) is to be used (IPROFL = 0) or not. Set to zero in TRCIN.		
NDIVS	/SYSPAR/	I*2	SYSPAR.INC
	Number of explicit diversity channels for AN/TRC-170. Equal to 4 for 2S/2F and 2 for 2S or 2F.		
SIGMA	/SYSPAR/	R*4	SYSPAR.INC
	Half the RMS lower beam delay spread normalized relative to the symbol duration.		
TO	/SYSPAR/	R*4	SYSPAR.INC
	Normalized sampling time for lower beam.		

CHAPTER 11

FINAL OUTPUT

This section describes the summary page output routines:

Name	Description	User's Manual section
SIM	Simulator tap gains	2.5.7
SUMPAG	Summary page output	3.4.2

The main routine for this section is SUMPAG. SUMPAG writes to the file SUMPAG.OUT on unit LSUM. A complete description of this file can be found in section 3.4.2 of the User's Manual.

NOTE

In most cases the sections in the User's Manual describe the coded equations as well as the theory behind them. NA denotes routines that are programming utilities such as finding indices, setting pointers, etc.

11.1 SIM

Subprogram name: Subroutine SIM

Purpose: Calculates troposcatter path simulator tap gains in dB, normalized so MAX TAP = 0 dB.

Calling sequence:
    CALL SIM

Contained in module: SIM

Called by: SUMPAG

Calls: NONE

Input arguments:
    NONE

Output arguments:
    NONE

Global variables input from common:

```
     DELPB             /PDATA/          R*4     PDATA.INC
                       Resolution of a delay cell in seconds.
     DIVTYP            /MCOM2/          I*2     MCOM.INC
                       Diversity configuration indicator.  Default is 0.
                        0 = 2 receive antennas; 2S    2S/2F    2S/2A 2S/2A/2F
                        1 = 1 receive antenna;  2A    2F       2F/2A
                        2 = 2 transmit,
                            2 receive antennas; 2S/2P 2S/2P/2A
                        3 = Not used
                        4 = User supplied parameters
                       S = Space  F = Frequency  A = Angle  P = Polarization
     I1CORR(NCORMX)    /PDATA/          I*2     PDATA.INC
                       Array of receiving beams involved in the correlation
                       calculations.
     I2CORR(NCORMX)    /PDATA/          I*2     PDATA.INC
                       Array of receiving beams involved in the correlation
                       calculations.
     IPROF(NCORMX)     /PDATA/          I*2     PDATA.INC
                       0 if the Ith correlation not wanted, 1 if wanted.
     LOUT              /LUNS/           I*2     LUNS.INC
                       FOR002.DAT output unit number.
     MLAST             /PDATA/          I*2     PDATA.INC
                       Number of simulator taps.  Default is 16.
     NCORMX            Parameter        I*2     TROPAR.INC
                       Maximum number of correlations between receive ports.
     NCORR             /PDATA/          I*2     PDATA.INC
                       Number of receive port correlations.
```

```
NDELMX              Parameter       I*2     TROPAR.INC
                    Maximum number of delay bins in troposcatter power per
                    unit delay profiles.
Q(NDELMX,NCORMX) /PDATA/            R*4     PDATA.INC
                    Matrix of troposcatter signal power and correlation
                    per unit delay profiles.
                    For DIVTYP = 0:
                       Q(.,1)  Power on lower beam vs. delay.
                       Q(.,2)  Correlation between lower and
                               upper beam vs. delay.
                       Q(.,3)  Correlation between lower beams
                               in antennas 1 & 2 vs. delay.
                       Q(.,4)  Power on upper beam vs. delay.
                       Q(.,7)  Power on diffraction path vs. delay
                    For DIVTYP = 1:
                       Q(.,1)  Power on lower beam vs. delay.
                       Q(.,2)  Correlation between lower and
                               upper beam vs. delay.
                       Q(.,3)  Power on upper beam vs. delay
                       Q(.,7)  Power on diffraction path vs. delay.
                    For DIVTYP = 2:
                       Q(.,1)  Power on path 1 (lower beam) vs. delay.
                       Q(.,2)  Correlation between convergent paths
                               (lower beam) vs. delay.
                       Q(.,3)  Correlation between divergent paths
                               (lower beam) vs. delay.
                       Q(.,4)  Correlation between parallel paths
                               (lower beam) vs. delay.
                       Q(.,5)  Correlation between crossing paths
                               (lower beam) vs. delay.
                       Q(.,6)  Power on path of upper beam vs. delay.
                       Q(.,7)  Power on diffraction path vs. delay.
SPE                 /PDATA/         R*4     PDATA.INC
                    Tap spacing in nanoseconds.  Default is 67 nsec.
```

11.2 SUMPAG

Subprogram name: Subroutine SUMPAG

Purpose: Outputs the summary file SUMPAG.OUT.

Description: The data on the first page is the principal link data. A second page is printed for modem information, if one was specified. The third page contains additional information relating to the common volume integration.

Subsequent pages list the delay power impulse response or cross-power (correlation) versus delay. One page is printed for each delay profile requested in the input data (IBR). The units are those specified by LUNITS.

Calling sequence:
CALL SUMPAG (PTYPE, BOUT, FOUT, JPOW, CLIMAT)

Contained in module: SUMPAG

Called by: TROPO

Calls: ANTPTR, ERROR, SIM, UNITCV

Input arguments:

PTYPE	I*2	Variable which indicates whether propagation mechanism is pure troposcatter (0 or 10) or mixed troposcatter-diffraction (1 or 11).
BOUT(3,4)	R*4	Yearly average fade outage probability for each bit error rate threshold specified and 2S/2F and 2S diversity configurations.
FOUT(3,4)	R*4	Yearly average fade outage probability per call minute for each bit error rate threshold specified and 2S/2F and 2S diversity configurations.
JPOW	R*8	Interference signal power density in dBm/Hz.
CLIMAT	R*4	Climate zone indicator.

Output arguments:

Global variables input from common:

AA	/PROPAR/	R*4	TROCOM.INC
	Atmospheric absorption loss in dB.		
ALFAO	/PATHGE/	R*4	TROCOM.INC
	Minimum transmit antenna elevation angle measured from transmitter-to-receiver line to transmit horizon line in radians.		
AR(NRMX)	/ANTENN/	R*4	TROCOM.INC
	Array of receiver antenna diameters in meters. AR(1)		

	is equivalent to RDIAM in the input file.		
AT(NTMX)	/ANTENN/	R*4	TROCOM.INC
	Array of transmitter antenna diameters in meters. AT(1) is equivalent to TDIAM in the input file.		
BER(3)	/ERAD/	R*4	ERAD.INC
	Bit error rate thresholds of interest. Set to 1E-3, 1E-4 and 1E-5 in data statement.		
BETA0	/PATHGE/	R*4	TROCOM.INC
	Minimum receive antenna elevation angle measured from receiver-to-transmitter line to receiver horizon line in radians.		
BW	/SYSTRN/	R*4	TROCOM.INC
	Bandwidth in Hertz. Default is 7 MHz.		
C	/PDATA/	R*4	PDATA.INC
	Proportionality constant in troposcatter path loss calculation.		
D	/PATHGE/	R*4	TROCOM.INC
	Great circle distance between transmitter and receiver measured at sea level in meters.		
DE	/SUMP/	R*4	CURVE.INC
	Effective distance for troposcatter path in kilometers.		
DEL	/SUMP/	R*4	CURVE.INC
	Diffraction path delay relative to a straight line path in seconds.		
DELPB	/PDATA/	R*4	PDATA.INC
	Resolution of a delay cell in seconds.		
DIFLOS(3)	/SUMP/	R*4	CURVE.INC
	Median diffraction path loss in dB for each value in ERFAC distribution.		
DIFRSL(3)	/SUMP/	R*4	CURVE.INC
	Median diffraction signal RSL in dBm for each value in ERFAC distribution.		
DIVTYP	/MCOM2/	I*2	MCOM.INC
	Diversity configuration indicator. Default is 0. 0 = 2 receive antennas; 2S 2S/2F 2S/2A 2S/2A/2F 1 = 1 receive antenna; 2A 2F 2F/2A 2 = 2 transmit, 2 receive antennas; 2S/2P 2S/2P/2A 3 = Not used 4 = User supplied parameters S = Space F = Frequency A = Angle P = Polarization		
DLR	/PATHGE/	R*4	TROCOM.INC
	Distance from receiver to radio horizon in meters.		
DLT	/PATHGE/	R*4	TROCOM.INC
	Distance from transmitter to radio horizon in meters.		
DSTSNR	/SUMP/	R*4	CURVE.INC
	Standard deviation of diffracted signal long-term SNR distribution in dB.		
ERFAC	/PROPAR/	R*4	TROCOM.INC

```
LOOPS .FTN contains the following subprograms:
   LOOPS , Subroutine

LTCORR.FTN contains the following subprograms:
   LTCORR, Subroutine

MATCO .FTN contains the following subprograms:
   MATCO , Subroutine

MATOPS.FTN contains the following subprograms:
   CHANGE, Subroutine
   MATA  , Subroutine
   SQTMAT, Subroutine

MDIF  .FTN contains the following subprograms:
   TANGL , Subroutine
   DIF1  , Subroutine
   MDIF  , Subroutine

MDTS  .FTN contains the following subprograms:
   MDTS  , Subroutine

MINV  .FTN contains the following subprograms:
   MINV  , Subroutine

ORDER .FTN contains the following subprograms:
   ORDER , Subroutine

OUTDAT.FTN contains the following subprograms:
   OUTDAT, Subroutine

POWER .FTN contains the following subprograms:
   POWER , Subroutine

PROUT .FTN contains the following subprograms:
   PROUT , Subroutine

RGAIN .FTN contains the following subprograms:
   RGAIN , Function

RIPROF.FTN contains the following subprograms:
   RIPROF, Subroutine

SASEQ .FTN contains the following subprograms:
   SASEQ , Subroutine

SIGIN .FTN contains the following subprograms:
   SIGIN , Subroutine
```

```
   VARPOL, Function

DELO  .FTN contains the following subprograms:
   DELO  , Subroutine

DIFSNR.FTN contains the following subprograms:
   DIFSNR, Subroutine

DINT  .FTN contains the following subprograms:
   CAKL  , Subroutine
   DINT  , Subroutine
   CAC   , Function

EIGEN .FTN contains the following subprograms:
   EIGEN , Subroutine

ELMES .FTN contains the following subprograms:
   ELMES , Subroutine
   HQR   , Subroutine

ERFC  .FTN contains the following subprograms:
   ERFC  , Function

ERLANG.FTN contains the following subprograms:
   ERLANG, Function

ERRIO .FTN contains the following subprograms:
   ERRIO , Subroutine

ERROR .FTN contains the following subprograms:
   ERROR , Subroutine

FRQSEP.FTN contains the following subprograms:
   FRQSEP, Subroutine

GPATT .FTN contains the following subprograms:
   GPATT , Subroutine

HORANG.FTN contains the following subprograms:
   HORANG, Subroutine

INDATA.FTN contains the following subprograms:
   INDATA, Subroutine
   SECTOR, Subroutine

INTLIM.FTN contains the following subprograms:
   INTLIM, Subroutine

JAMCOM.FTN contains the following subprograms:
   JAMCOM, Subroutine
```

```
      PDFCON, Subroutine

   BOTAC .FTN contains the following subprograms:
      BOTAC , Subroutine
      TPSPEC, Function
      TPSPJ , Function
      PWRSPC, Function
      RJCFCN, Function
      TSINC , Function

   BUTFIL.FTN contains the following subprograms:
      BUTFIL, Subroutine
      A50FCC, Function
      BWJAM , Subroutine
      ENRGF , Subroutine
      FCCMSK, Subroutine
      FFT   , Subroutine
      FUNBW , Function
      FUNJAM, Function
      INTERB, Subroutine
      PEAK  , Subroutine
      PSPEC , Function
      PSPEC1, Function
      PSPEC2, Function
      PSPJ  , Function
      RTMI  , Subroutine
      SAMPLE, Subroutine
      SEARCH, Subroutine
      SPEC  , Function
      SPEC1 , Function
      SPEC2 , Function

   CAJI  .FTN contains the following subprograms:
      CAJI  , Subroutine

   CHKDAT.FTN contains the following subprograms:
      CHKDAT, Subroutine

   CLIME .FTN contains the following subprograms:
      CLIME , Subroutine
      CLIFIT, Subroutine
      YINT  , Subroutine
      DEIND , Subroutine

   CLIMIL.FTN contains the following subprograms:
      CLIMIL, Subroutine
      VDECAL, Subroutine

   CLIMIX.FTN contains the following subprograms:
      CLIMIX, Subroutine
```

TGAIN ,	Function	TGAIN .FTN
TIMAVG,	Subroutine	TRC .FTN
TIMEQL,	Subroutine	TRC .FTN
TIMPAR,	Function	TRC .FTN
TPSPEC,	Function	BOTAC .FTN
TPSPJ ,	Function	BOTAC .FTN
TRANSF,	Subroutine	TRANSF.FTN
TRC ,	Subroutine	TRC .FTN
TRCIN ,	Subroutine	TRC .FTN
TRLOSS,	Subroutine	TRLOSS.FTN
TROPO ,	Main program	TROPO .FTN
TSINC ,	Function	BOTAC .FTN
TXPULS,	Function	TRC .FTN
UNITCV,	Subroutine	UNITCV.FTN
UNITS ,	Subroutine	UNITS .FTN
VARPOL,	Function	CLIMIX.FTN
VARW ,	Function	TRC .FTN
VDECAL,	Subroutine	CLIMIL.FTN
XNOR ,	Function	XNOR .FTN
YINT ,	Subroutine	CLIME .FTN

A.2 Module / Subprogram Reference Index

ANTGEO.FTN contains the following subprograms:
ANTGEO, Subroutine

ANTPAR.FTN contains the following subprograms:
ANTPAR, Subroutine

ANTPTR.FTN contains the following subprograms:
ANTPTR, Subroutine

ATMOS .FTN contains the following subprograms:
ATMOS , Subroutine

AVAIL .FTN contains the following subprograms:
AVAIL , Subroutine
CONVOL, Subroutine
INTERP, Subroutine

AVTER .FTN contains the following subprograms:
AVTER , Subroutine

BEAMPT.FTN contains the following subprograms:
BEAMPT, Subroutine

BERCAL.FTN contains the following subprograms:
BERCAL, Subroutine

INTLIM,	Subroutine	INTLIM.FTN
JAMCOM,	Subroutine	JAMCOM.FTN
LOOPS ,	Subroutine	LOOPS .FTN
LTCORR,	Subroutine	LTCORR.FTN
MATA ,	Subroutine	MATOPS.FTN
MATCO ,	Subroutine	MATCO .FTN
MDIF ,	Subroutine	MDIF .FTN
MDTS ,	Subroutine	MDTS .FTN
MINV ,	Subroutine	MINV .FTN
ORDER ,	Subroutine	ORDER .FTN
OUTDAT,	Subroutine	OUTDAT.FTN
P2INT ,	Function	TRC .FTN
PAVERG,	Subroutine	TRC .FTN
PDF ,	Function	TRC .FTN
PDFCOE,	Subroutine	TRC .FTN
PDFCON,	Subroutine	BERCAL.FTN
PDFSUM,	Function	TRC .FTN
PEAK ,	Subroutine	BUTFIL.FTN
POUTAG,	Subroutine	TRC .FTN
POWER ,	Subroutine	POWER .FTN
PROFIL,	Function	TRC .FTN
PROUT ,	Subroutine	PROUT .FTN
PSINE ,	Function	SINT .FTN
PSPEC ,	Function	BUTFIL.FTN
PSPEC1,	Function	BUTFIL.FTN
PSPEC2,	Function	BUTFIL.FTN
PSPJ ,	Function	BUTFIL.FTN
PWRSPC,	Function	BOTAC .FTN
RGAIN ,	Function	RGAIN .FTN
RIPROF,	Subroutine	RIPROF.FTN
RJCFCN,	Function	BOTAC .FTN
RTMI ,	Subroutine	BUTFIL.FTN
SAMPLE,	Subroutine	BUTFIL.FTN
SASEQ ,	Subroutine	SASEQ .FTN
SEARCH,	Subroutine	BUTFIL.FTN
SECTOR,	Subroutine	INDATA.FTN
SIGIN ,	Subroutine	SIGIN .FTN
SIM ,	Subroutine	SIM .FTN
SINC ,	Function	SINC .FTN
SINT ,	Subroutine	SINT .FTN
SPEC ,	Function	BUTFIL.FTN
SPEC1 ,	Function	BUTFIL.FTN
SPEC2 ,	Function	BUTFIL.FTN
SQTMAT,	Subroutine	MATOPS.FTN
STEPAB,	Function	STEPAB.FTN
STEPY ,	Function	STEPY .FTN
STPPAR,	Subroutine	STPPAR.FTN
SUBID ,	Subroutine	SUBID .FTN
SUMPAG,	Subroutine	SUMPAG.FTN
TANGL ,	Subroutine	MDIF .FTN

A.1 Subprogram / Module Reference Index

A50FCC,	Function	BUTFIL.FTN
ANTGEO,	Subroutine	ANTGEO.FTN
ANTPAR,	Subroutine	ANTPAR.FTN
ANTPTR,	Subroutine	ANTPTR.FTN
ATMOS ,	Subroutine	ATMOS .FTN
AVAIL ,	Subroutine	AVAIL .FTN
AVG ,	Subroutine	TRC .FTN
AVTER ,	Subroutine	AVTER .FTN
BEAMPT,	Subroutine	BEAMPT.FTN
BERCAL,	Subroutine	BERCAL.FTN
BOTAC ,	Subroutine	BOTAC .FTN
BUTFIL,	Subroutine	BUTFIL.FTN
BWJAM ,	Subroutine	BUTFIL.FTN
CAC ,	Function	DINT .FTN
CAJI ,	Subroutine	CAJI .FTN
CAKL ,	Subroutine	DINT .FTN
CHANGE,	Subroutine	MATOPS.FTN
CHKDAT,	Subroutine	CHKDAT.FTN
CLIFIT,	Subroutine	CLIME .FTN
CLIME ,	Subroutine	CLIME .FTN
CLIMIL,	Subroutine	CLIMIL.FTN
CLIMIX,	Subroutine	CLIMIX.FTN
CONVOL,	Subroutine	AVAIL .FTN
DEIND ,	Subroutine	CLIME .FTN
DELO ,	Subroutine	DELO .FTN
DIF1 ,	Subroutine	MDIF .FTN
DIFSNR,	Subroutine	DIFSNR.FTN
DINT ,	Subroutine	DINT .FTN
EIGEN ,	Subroutine	EIGEN .FTN
EIGV ,	Subroutine	TRC .FTN
ELMES ,	Subroutine	ELMES .FTN
ENRGF ,	Subroutine	BUTFIL.FTN
ERFC ,	Function	ERFC .FTN
ERLANG,	Function	ERLANG.FTN
ERRIO ,	Subroutine	ERRIO .FTN
ERROR ,	Subroutine	ERROR .FTN
FCCMSK,	Subroutine	BUTFIL.FTN
FFT ,	Subroutine	BUTFIL.FTN
FRQSEP,	Subroutine	FRQSEP.FTN
FUNBW ,	Function	BUTFIL.FTN
FUNJAM,	Function	BUTFIL.FTN
GPATT ,	Subroutine	GPATT .FTN
HORANG,	Subroutine	HORANG.FTN
HQR ,	Subroutine	ELMES .FTN
INDATA,	Subroutine	INDATA.FTN
INTERB,	Subroutine	BUTFIL.FTN
INTERD,	Subroutine	TRC .FTN
INTERP,	Subroutine	AVAIL .FTN

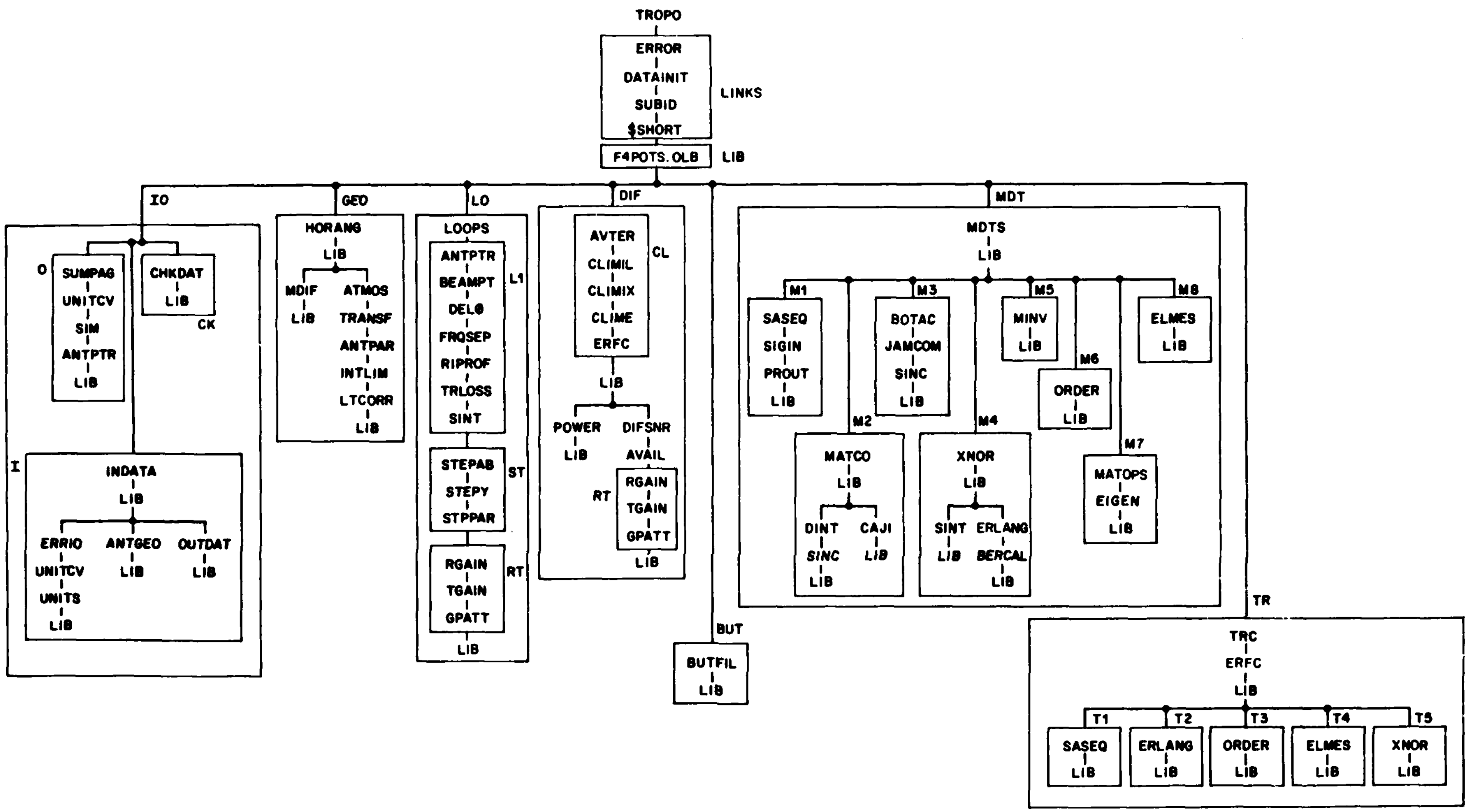

Figure A-1 Diagram of Overlay for PDP-11 Version of TROPO

APPENDIX A

PDP RELATED INFORMATION

The following information is only for those who are using the PDP version of TROPO (as opposed to the IBM version). If you are not sure which version you have, see the introduction to this document which describes the differences.

Figure A-1 is a chart of the overlay. The names refer to modules (source file names) rather than subprogram names. (The table in section A.3 lists the subprograms in each module.) TROPO is written in F4P Fortran so it must access the F4POTS module (Fortran library routines). The default library is whatever current version of Fortran is installed on your system. In order to insure that all modules are accessing F4P library functions and not F77 or other version functions, LIB is placed explicitly throughout the overlay. It is not sufficient to have it just in the root. It must be at the end of each branch.

This appendix will also aid in finding a particular subprogram or common. Since the PDP version is divided into modules or source files, finding a particular subprogram that is included in a module of a different name can be difficult. The following three tables will help:

1) The Subprogram / Module Reference Index
   This lists each subroutine or function alphabetically by name followed by the module it is in.
2) The Module / Subprogram Reference Index
   This lists each module and the subprograms it contains.
3) The Common / Include File Reference Index
   This lists each common followed by the include file it is in.

UDIST	/UNIT/	R*4	IODATA.INC	
	Units of distance (smi, nmi, km).			
UFREQ	/UNIT/	R*4	IODATA.INC	
	Units of frequency (GHz, MHz).			
UHITE	/UNIT/	R*4	IODATA.INC	
	Units of height and diameter (ft, m).			
URH(NR)	/PATHGE/	R*4	TROCOM.INC	
	Array of receive antennas horizontal offsets from great circle plane in meters.			
URL(NR)	/PATHGE/	R*4	TROCOM.INC	
	Array of receive antennas longitudinal offsets in meters.			
URV(NR)	/PATHGE/	R*4	TROCOM.INC	
	Array of receive antennas vertical offsets in meters.			
UTH(NT)	/PATHGE/	R*4	TROCOM.INC	
	Array of transmit antennas horizontal offsets in meters.			
UTL(NT)	/PATHGE/	R*4	TROCOM.INC	
	Array of transmit antennas longitudinal offsets in meters.			
UTV(NT)	/PATHGE/	R*4	TROCOM.INC	
	Array of transmit antennas vertical offsets in meters.			
WLT	/SYSTRN/	R*4	TROCOM.INC	
	Rated transmission power in Watts. Default is 1000 W.			

Global variables output to common:

IOPEND	/CONTRL/	I*2	TROCOM.INC
	Number of output files opened.		

paths.
QCORR(4) Correlation coefficient between parallel paths.
QCORR(5) Correlation coefficient between crossing paths.
QCORR(6) Power on upper beam.

RLL	/SYSTRN/	R*4	TROCOM.INC
	Receiver line losses in dB. Default is 0 dB.		
S	/PATHGE/	R*4	TROCOM.INC
	Troposcatter path asymmetry parameter.		
SCPARM	/PROPAR/	R*4	TROCOM.INC
	Wavenumber spectrum slope parameter M. Default is 3.66.		
SPREAD(NCORMX)	/PDATA/	R*4	PDATA.INC
	Array of delay spreads (2-sigma) for each beam in seconds.		
STSNR	/SUMP/	R*4	SUMP.INC
	Standard deviation of troposcatter signal long-term SNR distribution in dB.		
SUPRES	/IODATA/	L*4	IODATA.INC
	Supress long output in SUMPAG if true. Set to TRUE if PTYPE > 9.		
TAPOUT	/PDATA/	L*4	PDATA.INC
	If true, the simulator tap values are output to the output file, FOR002.DAT. Default is TRUE.		
TEMPA(NCORMX)	/PDATA/	R*4	PDATA.INC
	Array of average troposcatter signal delays for each beam relative to straight line in seconds.		
THER	/PATHGE/	R*4	TROCOM.INC
	Radio horizon elevation angle at receive site in radians.		
THET	/PATHGE/	R*4	TROCOM.INC
	Radio horizon elevation angle at transmit site in radians.		
THETAO	/PATHGE/	R*4	TROCOM.INC
	Scattering angle at bottom of common volume in radians.		
TLL	/SYSTRN/	R*4	TROCOM.INC
	Transmitter line losses in dB. Default is 0 dB.		
TODAY(9)	/TSTAMP/	L*1	IODATA.INC
	Array used in PDP-11 version to hold date as characters.		
TROLOS(3)	/SUMP/	R*4	CURVE.INC
	Median troposcatter path loss in dB for each value in ERFAC distribution.		
TRORSL(3)	/SUMP/	R*4	CURVE.INC
	Median troposcatter RSL in dBm for each value in ERFAC distribution.		
UANGLE	/UNIT/	R*4	IODATA.INC
	Units of angle (deg, mrad).		

```
                  is the main transmit antenna.
Q(NDELMX,NCORMX) /PDATA/        R*4     PDATA.INC
                  Matrix of troposcatter signal power and correlation
                  per unit delay profiles.
                  For DIVTYP = 0:
                     Q(.,1)  Power on lower beam vs. delay.
                     Q(.,2)  Correlation between lower and
                             upper beam vs. delay.
                     Q(.,3)  Correlation between lower beams
                             in antennas 1 & 2 vs. delay.
                     Q(.,4)  Power on upper beam vs. delay.
                     Q(.,7)  Power on diffraction path vs. delay
                  For DIVTYP = 1:
                     Q(.,1)  Power on lower beam vs. delay.
                     Q(.,2)  Correlation between lower and
                             upper beam vs. delay.
                     Q(.,3)  Power on upper beam vs. delay
                     Q(.,7)  Power on diffraction path vs. delay.
                  For DIVTYP = 2:
                     Q(.,1)  Power on path 1 (lower beam) vs. delay.
                     Q(.,2)  Correlation between convergent paths
                             (lower beam) vs. delay.
                     Q(.,3)  Correlation between divergent paths
                             (lower beam) vs. delay.
                     Q(.,4)  Correlation between parallel paths
                             (lower beam) vs. delay.
                     Q(.,5)  Correlation between crossing paths
                             (lower beam) vs. delay.
                     Q(.,6)  Power on path of upper beam vs. delay.
                     Q(.,7)  Power on diffraction path vs. delay.
QCORR(NCORMX)     /PDATA/       R*4     PDATA.INC
                  Contains elements of covariance matrix, ie, powers and
                  correlations.
                  For DIVTYP = 0:
                     QCORR(1) Power on lower beam
                     QCORR(2) Correlation coefficient between lower
                              and upper beam.
                     QCORR(3) Correlation coefficient between lower
                              beams of antennas 1 and 2
                     QCORR(4) Power on upper beam.
                  For DIVTYP = 1:
                     QCORR(1) Power on lower beam
                     QCORR(2) Correlation coefficient between lower
                              and upper beam.
                     QCORR(3) Power on upper beam.
                  For DIVTYP = 2:
                     QCORR(1) Power on path 1 (lower beam)
                     QCORR(2) Correlation coefficient between convergent
                              paths.
                     QCORR(3) Correlation coefficient between divergent
```

	Propagation/modem flag to select calculation mode. Default is 1. 0 = Propagation only 1 = Propagation + MD-918 modem 2 = Propagation + AN/TRC-170 or DAR modem 3 = Propagation + user-defined modem			
MODSIG	/MCOM2/	I*2	MCOM.INC	
	Interference signal modulation format. Default is 1. 0 = Analog FDM / FM 1 = Digital QPSK			
NACCU	/CONTRL/	I*2	TROCOM.INC	
	Parameter used as truncation point for common volume integration termination. Default is 40.			
NCORR	/PDATA/	I*2	PDATA.INC	
	Number of receive port correlations.			
NDELMX	Parameter	I*2	TROPAR.INC	
	Maximum number of delay bins in troposcatter power per unit delay profiles.			
NERT	/MCOM2/	I*2	MCOM.INC	
	Bit error rate threshold indicator for yearly fade outage probability calculation. Default is 2. 0 = All three thresholds 1 = For 10**(-3) only 2 = For 10**(-4) only 3 = For 10**(-5) only			
NEWCL(4)	/MCOM2/	I*2	MCOM.INC	
	New climate type character string.			
NOW(8)	/TSTAMP/	L*1	IODATA.INC	
	Array used in PDP-11/70 version to hold time of day as characters.			
NR	/SYSTRN/	I*2	TROCOM.INC	
	Number of receive ports.			
NT	/SYSTRN/	I*2	TROCOM.INC	
	Number of transmit ports.			
PLOSSM	/PDATA/	R*4	PDATA.INC	
	Troposcatter path loss from approximate analytic expression.			
PSIRAO(NRMX)	/ANTENN/	R*4	TROCOM.INC	
	Array of receiver beam azimuths in radians.			
PSIREO(NRMX)	/ANTENN/	R*4	TROCOM.INC	
	Array of receiver beam boresight elevations above radio horizon in radians, ie, angle at which each antenna is aimed relative to the horizon. PSIREO(1) is the main receive antenna.			
PSITAO(NTMX)	/ANTENN/	R*4	TROCOM.INC	
	Array of transmitter beam azimuths in radians.			
PSITEO(NTMX)	/ANTENN/	R*4	TROCOM.INC	
	Array of transmitter beam boresight elevations above radio horizon in radians, ie, angle at which each antenna is aimed relative to the horizon. PSITEO(1)			

```
                troposcatter integration.  It is an error if INEG > 0.
IPOLR(NRMX)     /ANTENN/        I*2     TROCOM.INC
                Array of receiver antenna polarizations.
IPOLT(NTMX)     /ANTENN/        I*2     TROCOM.INC
                Array of transmitter antenna polarizations.
IPOS            /PDATA/         I*2     PDATA.INC
                Number of delay cells exceeding the last allocated
                array element.  This number should be zero or small.
                IPOS > 0 is not a serious error unless the delay
                profile calculated has a clear peak in the last delay
                cell.
IPROF(NCORMX)   /PDATA/         I*2     PDATA.INC
                0 if the Ith correlation not wanted, 1 if wanted.
ITER            /PDATA/         I*4     PDATA.INC
                Number of integration cells in the common volume
                integration.
LINKNO          /IODATA/        I*2     IODATA.INC
                Link number.
LNAME(20)       /IODATA/        I*2     IODATA.INC
                Link name.  Transmitter site first, receiver site
                second.  Used as link identifier on output files
                FOR002.DAT and SUMPAG.OUT.
LSUM            /LUNS/          I*2     LUNS.INC
                SUMPAG.OUT output unit number.
LUNITS          /UNIT/          I*2     IODATA.INC
                Integer value that specifies the set of units
                requested by the user.  These units are for path,
                antenna location, angle, and frequency parameters.
                Default is 8.  The given units are defined by bit
                values of LUNITS:
                Bit no.        Meaning of value 0 / 1
                  0            english / metric
                  1            statute miles / nautical miles
                  2            feet / meters
                  3            mrad / degrees
                  4            GHz / MHz
                Valid LUNITS values are
                0 :   stat. miles  - feet   - milliradians - GHz
                1 :   kilometers   - meters - milliradians - GHz
                2 :   naut. miles  - feet   - milliradians - GHz
                8 :   stat. miles  - feet   - degrees      - GHz
                9 :   kilometers   - meters - degrees      - GHz
                10:   naut.miles   - feet   - degrees      - GHZ
                16:   stat. miles  - feet   - milliradians - MHz
                17:   kilometers   - meters - milliradians - MHz
                18:   naut. miles  - feet   - milliradians - MHz
                24:   stat. miles  - feet   - degrees      - MHz
                25:   kilometers   - meters - degrees      - MHz
                26:   naut. miles  - feet   - degrees      - MHz
MODPAT          /MCOM2/         I*2     MCOM.INC
```

	Yearly median value of effective earth radius factor k in kilometers. Default is 1.33.			
ERR	/CONTROL/	R*4	TROCOM.INC	
	Common volume integration resolution. Default is .001.			
F	/SYSTRN/	R*4	TROCOM.INC	
	Operating frequency in Hz. Model is accurate between 100MHz and 10GHz.			
FSEP	/PDATA/	R*4	PDATA.INC	
	Frequency separation for uncorrelated frequency diversity in Hz.			
GRDB(NRMX)	/ANTENN/	R*4	TROCOM.INC	
	Gain of each receive antenna in dBi.			
GTDB(NTMX)	/ANTENN/	R*4	TROCOM.INC	
	Gain of each transmit antenna in dBi.			
HCOM	/PATHGE/	R*4	TROCOM.INC	
	Effective height of the bottom of the common volume in meters.			
HHIGH	/PATHGE/	R*4	TROCOM.INC	
	Effective height of the top of the common volume in meters.			
HLR	/PATHGE/	R*4	TROCOM.INC	
	Receiver radio horizon elevation above sea level in meters.			
HLT	/PATHGE/	R*4	TROCOM.INC	
	Transmit radio horizon elevation above sea level in meters.			
HRN	/PATHGE/	R*4	TROCOM.INC	
	Receive antenna height above sea level in meters.			
HTN	/PATHGE/	R*4	TROCOM.INC	
	Transmit antenna height above sea level in meters.			
I1CORR(NCORMX)	/PDATA/	I*2	PDATA.INC	
	Array of receiving beams involved in the correlation calculations.			
I2CORR(NCORMX)	/PDATA/	I*2	PDATA.INC	
	Array of receiving beams involved in the correlation calculations.			
IBR(NRMX,NRMX)	/SYSTRN/	I*2	TROCOM.INC	
	Channel complex-envelope correlation and cross-correlation calculation indicator array. 0 = No calculation 1 = Power (correlation) calculation only 2 = Power (correlation) per unit delay spectrum calculation			
ICLIME	/MCOM2/	I*2	MCOM.INC	
	Climate class. Default is 0. 0 = NBS TN-101 climate 1 = MIL-HDBK-417 climate 2 = New, user-supplied climate			
INEG	/PDATA/	I*2	PDATA.INC	
	Number of negative delay cells encountered in			

```
SIM   .FTN contains the following subprograms:
   SIM   , Subroutine

SINC  .FTN contains the following subprograms:
   SINC  , Function

SINT  .FTN contains the following subprograms:
   SINT  , Subroutine
   PSINE , Function

STEPAB.FTN contains the following subprograms:
   STEPAB, Function

STEPY .FTN contains the following subprograms:
   STEPY , Function

STPPAR.FTN contains the following subprograms:
   STPPAR, Subroutine

SUBID .FTN contains the following subprograms:
   SUBID , Subroutine

SUMPAG.FTN contains the following subprograms:
   SUMPAG, Subroutine

TGAIN .FTN contains the following subprograms:
   TGAIN , Function

TRANSF.FTN contains the following subprograms:
   TRANSF, Subroutine

TRC   .FTN contains the following subprograms:
   AVG   , Subroutine
   EIGV  , Subroutine
   INTERD, Subroutine
   PAVERG, Subroutine
   PDF   , Function
   PDFCOE, Subroutine
   PDFSUM, Function
   POUTAG, Subroutine
   PROFIL, Function
   P2INT , Function
   TIMAVG, Subroutine
   TIMEQL, Subroutine
   TIMPAR, Function
   TRC   . Subroutine
   TRCIN , Subroutine
   TXPULS, Function
   VARW  , Function
```

TRLOSS.FTN contains the following subprograms:
TRLOSS, Subroutine

TROPO .FTN contains the following subprograms:
TROPO , Main Program

UNITCV.FTN contains the following subprograms:
UNITCV, Subroutine

UNITS .FTN contains the following subprograms:
UNITS , Subroutine

XNOR .FTN contains the following subprograms:
XNOR , Function

A.3 Common / Include File Reference Index

/ANSWER/	ANSWER.INC
/ANTENN/	TROCOM.INC
/BUTPAR/	BUTPAR.INC
/CONSTA/	CONSTANTS.INC
/CONTRL/	TROCOM.INC
/CPLOSS/	CPL.INC
/CURVE/	CURVE.INC
/ERAD/	ERAD.INC
/IODATA/	IODATA.INC
/IOUT/	IOUT.INC
/JAMPAR/	JAMPAR.INC
/LUNS/	LUNS.INC
/MCOM2/	MCOM.INC
/MCOM4/	MCOM.INC
/NUMPAR/	NUMPAR.INC
/PATHGE/	TROCOM.INC
/PDATA/	PDATA.INC
/PROPAR/	TROCOM.INC
/RI2/	RI2.INC
/RZ/	RZ.INC
/RZ1/	RZ1.INC
/RZ4/	RZ4.INC
/STPCOM/	STPCOM.INC
/SUMP/	SUMP.INC
/SYSPAR/	SYSPAR.INC
/SYSTRN/	TROCOM.INC
/TSTAMP/	IODATA.INC
/UNIT/	IODATA.INC

APPENDIX B

CALL CROSS-REFERENCE

The subprogram cross-reference shows which subprograms call the described subprogram and which subprograms it calls. A similar list appears for each subprogram in the main description of it but the following list also includes system routines such as SIN as well as statement functions. In the following list MAIN refers to the driver or main routine, TROPO.

B.1 Call Cross-Reference Table

ANTGEO
 Is called by the following subprograms:
 INDATA

ANTPAR
 Is called by the following subprograms:
 TROPO
 Calls the following subprgrams:
 ALOG10 ERROR

ANTPTR
 Is called by the following subprograms:
 LOOPS SUMPAG

ATMOS
 Is called by the following subprograms:
 TROPO
 Calls the following subprgrams:
 ERROR

AVAIL
 Is called by the following subprograms:
 DIFSNR
 Calls the following subprgrams:
 CLIME CLIMIL CLIMIX CONVOL INTERP SQRT SUBID

```
AVG
 Is called by the following subprograms:
        TRC
 Calls the following subprgrams:
        PDF     YRUTIN

AVTER
 Is called by the following subprograms:
        DIFSNR  POWER

ASOFCC
 Is called by the following subprograms:
        FCCMSK  FUNBW
 Calls the following subprgrams:
        ALOG10  PSPEC

BEAMPT
 Is called by the following subprograms:
        LOOPS

BERCAL
 Is called by the following subprograms:
        MDTS
 Calls the following subprgrams:
        ALOG10  DABS    DLOG    DLOG10  DMAX1   ERLANG  EXP     PDFCON
        SUBID   XNOR

BOTAC
 Is called by the following subprograms:
        MDTS
 Calls the following subprgrams:
        JAMCOM  RJCFCN  SUBID   TSINC

BUTFIL
 Is called by the following subprograms:
        TROPO
 Calls the following subprgrams:
        ABS     ALOG10  AMAX1   BWJAM   EXP     FUNBW   FUNJAM  F1
        F2      PEAK    PSPEC1  PSPEC2  SAMPLE  SIN     SPEC1   SPEC2
        SQRT    SUBID

BWJAM
 Is called by the following subprograms:
        BUTFIL
 Calls the following subprgrams:
        ALOG10  ENRGF   FUNBW   FUNJAM  RTMI    SEARCH

CAC
 Is called by the following subprograms:
        DINT    MATCO
```

```
 Calls the following subprgrams:
        ABS      DSQRT   SINC

CAJI
 Is called by the following subprograms:
        MATCO
 Calls the following subprgrams:
        ABS      AMAX1   IABS

CAKL
 Is called by the following subprograms:
        MATCO
 Calls the following subprgrams:
        DINT

CHANGE
 Is called by the following subprograms:
        MDTS     SQTMAT
 Calls the following subprgrams:
        ERROR

CHKDAT
 Is called by the following subprograms:
        TROPO
 Calls the following subprgrams:
        ABS      ERROR

CLIFIT
 Is called by the following subprograms:
        CLIME    CLIMIL
 Calls the following subprgrams:
        ABS      EXP     F1      F2      SUBID

CLIME
 Is called by the following subprograms:
        AVAIL    CLIMIX  POWER
 Calls the following subprgrams:
        ALOG10   CLIFIT  DEIND   ERROR   EXP     F2      SIN     YINT

CLIMIL
 Is called by the following subprograms:
        AVAIL    POWER
 Calls the following subprgrams:
        ALOG10   CLIFIT  ERROR   SIN     VDECAL

CLIMIX
 Is called by the following subprograms:
        AVAIL    POWER
 Calls the following subprgrams:
        ABS      CLIME   ERFC    ERROR   SQRT    SUBID   VARPOL
```

CONVOL
Is called by the following subprograms:
AVAIL
Calls the following subprsrams:
INTERP

DEIND
Is called by the following subprograms:
CLIME
Calls the following subprsrams:
ERROR

DELO
Is called by the following subprograms:
LOOPS
Calls the following subprsrams:
COS SIN

DIFSNR
Is called by the following subprograms:
TROPO
Calls the following subprsrams:
ABS ALOG10 AVAIL AVTER ERFC KGAIN SIGN SQRT
SUBID TGAIN

DIF1
Is called by the following subprograms:
MDIF
Calls the following subprsrams:
ABS ALOG10 ATAN COS SQRT

DINT
Is called by the following subprograms:
CAKL MDTS
Calls the following subprsrams:
CAC DFLOAT

EIGEN
Is called by the following subprograms:
MDTS SQTMAT
Calls the following subprsrams:
ABS FLOAT SQRT

EIGV
Is called by the following subprograms:
TRC
Calls the following subprsrams:
ELMES HQR ORDER PROFIL TXPULS

ELMES
Is called by the followins subprosrams:
EIGV MDTS
Calls the followins subprsrams:
DABS

ENRGF
Is called by the followins subprosrams:
BWJAM FUNBW FUNJAM
Calls the followins subprsrams:
PSPEC

ERFC
Is called by the followins subprosrams:
CLIMIX DIFSNR PAVERG POUTAG POWER
Calls the followins subprsrams:
EXP SIGN

ERLANG
Is called by the followins subprosrams:
BERCAL PDF PDFSUM
Calls the followins subprsrams:
DABS DEXP

ERRIO
Is called by the followins subprosrams:
INDATA SECTOR UNITS

ERROR
Is called by the followins subprosrams:
ANTPAR ATMOS CHANGE CHKDAT CLIME CLIMIL CLIMIX DEIND
LOOPS MATA MDIF MDTS ORDER RIPROF SIGIN SQTMAT
SUMPAG TRANSF TRCIN TRLOSS UNITCV VARPOL

FCCMSK
Is called by the followins subprosrams:
FUNBW
Calls the followins subprsrams:
ALOG10 A50FCC

FFT
Is called by the followins subprosrams:
SAMPLE
Calls the followins subprsrams:
CMPLX COS SIN

FRQSEP
Is called by the followins subprosrams:
LOOPS
Calls the followins subprsrams:

```
        ABS     COS     SIN     SQRT

FUNBW
 Is called by the following subprograms:
        BUTFIL  BWJAM
 Calls the following subprgrams:
        A50FCC  ENRGF   FCCMSK  INTERB  PSPEC

FUNJAM
 Is called by the following subprograms:
        BUTFIL  BWJAM
 Calls the following subprgrams:
        ALOG10  ENRGF   F1      F2      PSPEC   PSPJ

GPATT
 Is called by the following subprograms:
        RGAIN   TGAIN
 Calls the following subprgrams:
        ABS     SIN

HORANG
 Is called by the following subprograms:
        TANGL   TRANSF
 Calls the following subprgrams:
        ASIN    SIN     SQRT

HQR
 Is called by the following subprograms:
        EIGV    MOTS
 Calls the following subprgrams:
        DABS    DSIGN   DSQRT

INDATA
 Is called by the following subprograms:
        TROPO
 Calls the following subprgrams:
        ALOG10  AMOD    ANTGEO  ERRIO   EXP     OUTDAT  SECTOR  TRC
        UNITCV  UNITS

INTERB
 Is called by the following subprograms:
        FUNBW

INTERD
 Is called by the following subprograms:
        POUTAG  TIMAVG

INTERP
 Is called by the following subprograms:
        AVAIL   CONVOL
```

```
 Calls the following subprgrams:
       ESTF

INTLIM
 Is called by the following subprograms:
       TROPO
 Calls the following subprgrams:
       AMAX1   AMIN1   COS     SIN     SQRT

JAMCOM
 Is called by the following subprograms:
       BOTAC
 Calls the following subprgrams:
       ACOS    ATAN    COS     SIN     SQRT    TAN     TSINC

LOOPS
 Is called by the following subprograms:
       TROPO
 Calls the following subprgrams:
       ABS     ANTPTR  ASIN    BEAMPT  COS     DELO    ERROR   EXP
       FRQSEP  RGAIN   RIPROF  SIN     SINT    SQRT    STEPAB  STEPY
       STPPAR  TGAIN   TRLOSS

LTCORR
 Is called by the following subprograms:
       TROPO
 Calls the following subprgrams:
       EXP     SIN     SQRT

TROPO
 Calls the following subprgrams:
       ANTPAR  ATMOS   BUTFIL  CHKDAT  DATE    DIFSNR  INDATA  INTLIM
       LOOPS   LTCORR  MDIF    MDTS    POWER   SUBID   SUMPAG  TIME
       TRANSF  TRCIN

MATA
 Is called by the following subprograms:
       MDTS    SQTMAT
 Calls the following subprgrams:
       ERROR

MATCO
 Is called by the following subprograms:
       MDTS
 Calls the following subprgrams:
       CAC     CAJI    CAKL    SUBID

MDIF
 Is called by the following subprograms:
       TROPO
```

Calls the following subprgrams:
ABS ALOG10 AMIN1 COS DIF1 ERROR SIN SUBID
TANGL

MDTS
Is called by the following subprograms:
TROPO
Calls the following subprgrams:
ACOS AMOD BERCAL BOTAC CHANGE COS DINT DLOG10
DSIN EIGEN ELMES ERROR HQR MATA MATCO MINV
ORDER PROUT SASEQ SIGIN SINT SQTMAT SUBID XNOR

MINV
Is called by the following subprograms:
MDTS
Calls the following subprgrams:
DABS

ORDER
Is called by the following subprograms:
EIGV MDTS
Calls the following subprgrams:
ERROR

OUTDAT
Is called by the following subprograms:
INDATA
Calls the following subprgrams:
DATE SUBID TIME

PAVERG
Is called by the following subprograms:
TRC
Calls the following subprgrams:
ERFC EXP SQRT

PDF
Is called by the following subprograms:
AVG PDFSUM
Calls the following subprgrams:
ERLANG

PDFCOE
Is called by the following subprograms:
TRC
Calls the following subprgrams:
EXP

PDFCON
Is called by the following subprograms:

```
        BERCAL
  Calls the following subprgrams:
        DABS

 PDFSUM
  Is called by the following subprograms:
        TRC
  Calls the following subprgrams:
        ERLANG  PDF

 PEAK
  Is called by the following subprograms:
        BUTFIL
  Calls the following subprgrams:
        ABS

 POUTAG
  Is called by the following subprograms:
        TRC
  Calls the following subprgrams:
        ERFC    INTERD

 POWER
  Is called by the following subprograms:
        TROPO
  Calls the following subprgrams:
        ABS     ALOG10  AVTER   CLIME   CLIMIL  CLIMIX  ERFC    SIGN
        SQRT    SUBID

 PROFIL
  Is called by the following subprograms:
        EIGV    TIMPAR  VARW
  Calls the following subprgrams:
        EXP

 PROUT
  Is called by the following subprograms:
        MDTS
  Calls the following subprgrams:
        SUBID

 PSINE
  Is called by the following subprograms:
        SINT
  Calls the following subprgrams:
        DSIN    F1      F2

 PSPEC
  Is called by the following subprograms:
        A5OFCC  ENRGF   FUNBW   FUNJAM  PSPEC1  PSPEC2  PSPJ
```

Calls the following subprgrams:
SIN

PSPEC1
Is called by the following subprograms:
BUTFIL
Calls the following subprgrams:
CMPLX PSPEC

PSPEC2
Is called by the following subprograms:
BUTFIL
Calls the following subprgrams:
CMPLX PSPEC PSPJ

PSPJ
Is called by the following subprograms:
FUNJAM PSPEC2
Calls the following subprgrams:
EXP PSPEC SQRT

PWRSPC
Is called by the following subprograms:
RJCFCN
Calls the following subprgrams:
TPSPEC TPSPJ

P2INT
Is called by the following subprograms:
TIMPAR VARW
Calls the following subprgrams:
TXPULS

RGAIN
Is called by the following subprograms:
DIFSNR LOOPS
Calls the following subprgrams:
GPATT

RIPROF
Is called by the following subprograms:
LOOPS
Calls the following subprgrams:
ERROR

RJCFCN
Is called by the following subprograms:
BOTAC
Calls the following subprgrams:
COS PWRSPC

RTMI
Is called by the followins subprosrams:
BWJAM SEARCH
Calls the followins subprsrams:
ABS SIGN

SAMPLE
Is called by the followins subprosrams:
BUTFIL
Calls the followins subprsrams:
FFT REAL

SASEQ
Is called by the followins subprosrams:
MDTS TRCIN
Calls the followins subprsrams:
MOD

SEARCH
Is called by the followins subprosrams:
BWJAM
Calls the followins subprsrams:
RTMI SIN

SECTOR
Is called by the followins subprosrams:
INDATA
Calls the followins subprsrams:
ERRIO

SIGIN
Is called by the followins subprosrams:
MDTS
Calls the followins subprsrams:
ERROR EXP

SIM
Is called by the followins subprosrams:
SUMFAG
Calls the followins subprsrams:
ALOG10 IABS SQRT SUBID

SINC
Is called by the followins subprosrams:
CAC TSINC
Calls the followins subprsrams:
ABS SIN

SINT

Is called by the following subprograms:
LOOPS MDTS
Calls the following subprgrams:
IABS PSINE SUBID

SPEC
Is called by the following subprograms:
SPEC1 SPEC2
Calls the following subprgrams:
CMPLX COS SIN

SPEC1
Is called by the following subprograms:
BUTFIL
Calls the following subprgrams:
SPEC

SPEC2
Is called by the following subprograms:
BUTFIL
Calls the following subprgrams:
SPEC

SQTMAT
Is called by the following subprograms:
MDTS
Calls the following subprgrams:
CHANGE EIGEN ERROR MATA SQRT

STEPAB
Is called by the following subprograms:
LOOPS

STEPY
Is called by the following subprograms:
LOOPS
Calls the following subprgrams:
SQRT

STPPAR
Is called by the following subprograms:
LOOPS
Calls the following subprgrams:
ABS AMIN1 SQRT

SUBID
Is called by the following subprograms:
AVAIL BERCAL BOTAC BUTFIL CLIFIT CLIMIX DIFSNR TROPO
MATCO MDIF MDTS OUTDAT POWER PROUT SIM SINT
TRC TRCIN

```
                - Used but not chansed in the followins subprosrams:
                  INTLIM  STPPAR
256)            /RZ/            R*8     RZ.INC
                Sisnal response after PN sequence correlation.
                - Possibly siven a new value in the followins subprosrams:
                  SINT
                - Used but not chansed in the followins subprosrams:
                  CAC     CAJI
256)            /RZ4/           R*4     RZ4.INC
                Impulse response of cascade of transmitter and
                receiver filters, and cascade of interferer and
                receiver filters.
                -- Not used --
256)            /RZ4/           R*4     RZ4.INC
                Autocorrelation of receiver filter.
                -- Not used --
MIN             /NUMPAR/        R*4     NUMPAR.INC
                Ratio of smallest to larsest eisenvalue in AN/TRC-170
                performance calculations.
                - Used but not chansed in the followins subprosrams:
                  TRC
NG(10)          /MCOM4/         R*4     MCOM.INC
                Interferer elevation ansles in desrees.  Default is 0.
                - Possibly siven a new value in the followins subprosrams:
                  INDATA
                - Used but not chansed in the followins subprosrams:
                  JAMCOM  MDTS    OUTDAT
EAN             /ANSWER/        R*4     ANSWER.INC
                Averase received enersy.
                - Possibly siven a new value in the followins subprosrams:
                  EIGV
                - Used but not chansed in the followins subprosrams:
                  TRC
AR              /ANSWER/        R*4     ANSWER.INC
                Variance of received enersy.
                - Possibly siven a new value in the followins subprosrams:
                  EIGV
                /CONTRL/        L*4     TROCOM.INC
                End of TROPO.DAT file found if TRUE.
                - Possibly siven a new value in the followins subprosrams:
                  INDATA
                - Used but not chansed in the followins subprosrams:
                  MAIN
AC              /PROPAR/        R*4     TROCOM.INC
                Yearly median value of effective earth radius factor k
                in kilometers.  Default is 1.33.
                - Possibly siven a new value in the followins subprosrams:
                  INDATA  MAIN
                - Used but not chansed in the followins subprosrams:
                  OUTDAT  POWER   SUMPAG  TRANSF
```

```
                 OUTDAT  POWER   SUMPAG  TRANSF
.T              /PATHGE/        R*4     TROCOM.INC
                Distance from transmitter to radio horizon in meters.
                - Possibly given a new value in the following subprograms:
                  INDATA  UNITCV
                - Used but not changed in the following subprograms:
                  OUTDAT  POWER   SUMPAG  TRANSF
R               /PATHGE/        R*4     TROCOM.INC
                Receiver distance to minimum scattering point in
                meters.
                - Possibly given a new value in the following subprograms:
                  TRANSF  UNITCV
                - Used but not changed in the following subprograms:
                  INTLIM  STPPAR
RATE            /MCOM4/         R*4     MCOM.INC
                Data rate in bits/second.  Default is 6.6E6.
                - Possibly given a new value in the following subprograms:
                  INDATA
                - Used but not changed in the following subprograms:
                  CAC     DIFSNR  DINT    JAMCOM  MAIN    MDTS    OUTDAT  POWER
                  SIGIN
S(3)            /MCOM4/         R*4     MCOM.INC
                Array of effective obstacle extents along the great
                circle path in meters.
                - Possibly given a new value in the following subprograms:
                  INDATA  UNITCV
                - Used but not changed in the following subprograms:
                  MAIN    OUTDAT
SP1(3)          /SUMP/          R*4     CURVE.INC
                Lower beam troposcatter signal RMS delay spread in
                nanoseconds for percentiles 50, 90 and 99.
                - Possibly given a new value in the following subprograms:
                  POWER
SP2(3)          /SUMP/          R*4     CURVE.INC
                Upper beam troposcatter signal RMS delay spread in
                nanoseconds for percentiles 50, 90 and 99.
                - Possibly given a new value in the following subprograms:
                  POWER
STSNR           /SUMP/          R*4     CURVE.INC
                Standard deviation of diffracted signal long-term SNR
                distribution in dB.
                - Possibly given a new value in the following subprograms:
                  DIFSNR
                - Used but not changed in the following subprograms:
                  MDTS    SUMPAG
T               /PATHGE/        R*4     TROCOM.INC
                Transmit antenna distance to minimum scattering point
                in meters.
                - Possibly given a new value in the following subprograms:
                  TRANSF  UNITCV
```

```
                variability curve, YO(90).
                - Possibly given a new value in the following subprograms:
                  CLIMIL  INDATA
                - Used but not changed in the following subprograms:
                  CLIFIT  CLIME   OUTDAT
IFLOS(3)        /SUMP/          R*4     CURVE.INC
                Median diffraction path loss in dB for each value in
                ERFAC distribution.
                - Possibly given a new value in the following subprograms:
                  DIFSNR
                - Used but not changed in the following subprograms:
                  SUMPAG
IFRSL(3)        /SUMP/          R*4     CURVE.INC
                Median diffraction signal RSL in dBm for each value in
                ERFAC distribution.
                - Possibly given a new value in the following subprograms:
                  DIFSNR
                - Used but not changed in the following subprograms:
                  SUMPAG
IVIMP           /ANSWER/        R*4     ANSWER.INC
                Ratio of square of mean signal energy to variance for
                AN/TRC-170.
                - Possibly given a new value in the following subprograms:
                  EIGV
IVTYP           /MCOM2/         I*2     MCOM.INC
                Diversity configuration indicator.  Default is 0.
                 0 = 2 receive antennas; 2S    2S/2F    2S/2A 2S/2A/2F
                 1 = 1 receive antenna;  2A    2F       2F/2A
                 2 = 2 transmit,
                     2 receive antennas; 2S/2P 2S/2P/2A
                 3 = Not used
                 4 = User supplied parameters
                S = Space  F = Frequency  A = Angle  P = Polarization
                - Possibly given a new value in the following subprograms:
                  INDATA
                - Used but not changed in the following subprograms:
                  ANTGEO  BERCAL  CAC     LTCORR  MATCO   MDTS    OUTDAT  POWER
                  SIM     SUMPAG
L(3)            /MCOM4/         R*4     MCOM.INC
                Array containing distance from each obstacle to
                transmitter in meters.
                - Possibly given a new value in the following subprograms:
                  INDATA  UNITCV
                - Used but not changed in the following subprograms:
                  DIFSNR  MAIN    OUTDAT
LR              /PATHGE/        R*4     TROCOM.INC
                Distance from receiver to radio horizon in meters.
                - Possibly given a new value in the following subprograms:
                  INDATA  UNITCV
                - Used but not changed in the following subprograms:
```

```
DEG             /UNIT/          R*4     IODATA.INC
                Strins 'des ' for units output.
                - Used but not chansed in the followins subprosrams:
                  OUTDAT  UNITS
DEL             /SUMP/          R*4     CURVE.INC
                Diffraction path delay relative to a straisht line
                path in seconds.
                - Used but not chansed in the followins subprosrams:
                  MAIN    MDTS    SUMPAG
DELH            /PROPAR/        R*4     TROCOM.INC
                Spacins of CN2 samples in meters.
                - Possibly siven a new value in the followins subprosrams:
                  INDATA  UNITCV
                - Used but not chansed in the followins subprosrams:
                  OUTDAT  RIPROF
DELPB           /PDATA/         R*4     PDATA.INC
                Resolution of a delay cell in seconds.
                - Possibly siven a new value in the followins subprosrams:
                  LOOPS
                - Used but not chansed in the followins subprosrams:
                  MAIN    MDIF    POWER   SIM     SUMPAG
DELPBZ          /RZ1/           R*4
                Resolution of a delay cell in seconds.  Same as DELPB
                in /PDATA/.
                - Possibly siven a new value in the followins subprosrams:
                  MAIN
                - Used but not chansed in the followins subprosrams:
                  CAC     DINT
DELREF          /PDATA/         R*4     PDATA.INC
                Minimum delay throush the lowest scatterins point
                (relative to straisht line delay) in seconds.
                - Possibly siven a new value in the followins subprosrams:
                  MDIF
                - Used but not chansed in the followins subprosrams:
                  LOOPS   POWER
DELTAR(NRMX)    /ANTENN/        R*4     TROCOM.INC
                3dB half-beamwidth of each receive antenna in radians.
                - Possibly siven a new value in the followins subprosrams:
                  MAIN
                - Used but not chansed in the followins subprosrams:
                  INTLIM  POWER   STPPAR  TRANSF  TRLOSS
DELTAT(NTMX)    /ANTENN/        R*4     TROCOM.INC
                3dB half-beamwidth of each transmit antenna in
                radians.
                - Possibly siven a new value in the followins subprosrams:
                  MAIN
                - Used but not chansed in the followins subprosrams:
                  INTLIM  POWER   STPPAR  TRANSF  TRLOSS
DEMIN           /CURVE/         R*4     CURVE.INC
                User supplied minima of the 90th percentile
```

```
                     - Used but not changed in the following subprograms:
                       OUTDAT  RIPROF
CODE                 /MCOM4/         L*4     MCOM.INC
                     Flag for coding.
                     - Possibly given a new value in the following subprograms:
                       INDATA
                     - Used but not changed in the following subprograms:
                       MDTS
COEFF                /ANSWER/        R*8     ANSWER.INC
                     Partial fraction expansion coefficients for
                     calculation of AN/TRC-170 outage probability.
                     - Used but not changed in the following subprograms:
                       AVG     TRC
CONJAM               /JAMPAR/        R*4     JAMPAR.INC
                     Interference constant.
                     - Possibly given a new value in the following subprograms:
                       BUTFIL  BWJAM
                     - Used but not changed in the following subprograms:
                       FUNJAM
CORRLT               /CPLOSS/        R*4     CPL.INC
                     Correlation coefficient for long term variability of
                     lower and upper beams.
                     - Possibly given a new value in the following subprograms:
                       LTCORR
                     - Used but not changed in the following subprograms:
                       POWER
CPL(6)               /CPLOSS/        R*4     CPL.INC
                     Aperture-to-medium coupling loss array in dB.
                     - Possibly given a new value in the following subprograms:
                       TRLOSS
                     - Used but not changed in the following subprograms:
                       POWER
D                    /PATHGE/        R*4     TROCOM.INC
                     Great circle distance between transmitter and receiver
                     measured at sea level in meters.
                     - Possibly given a new value in the following subprograms:
                       INDATA  UNITCV
                     - Used but not changed in the following subprograms:
                       ATMOS   DIFSNR  INTLIM  LOOPS   LTCORR  MAIN    OUTDAT  POWER
                       SUMPAG  TRANSF  TRLOSS
DALT                 /RZ4/           R*4     RZ4.INC
                     Sampling interval.
                     -- Not used --
DE                   /SUMP/          R*4     CURVE.INC
                     Effective distance for troposcatter path in
                     kilometers.
                     - Possibly given a new value in the following subprograms:
                       POWER
                     - Used but not changed in the following subprograms:
                       SUMPAG
```

```
                normalized to signaling interval duration.
                - Possibly given a new value in the following subprograms:
                  TRCIN
                - Used but not changed in the following subprograms:
                  TRC     TXPULS
CE3             /CONSTA/        R*4     CONSTANTS.INC
                1 X 10**3 = 1000.
                - Used but not changed in the following subprograms:
                  UNITCV
CHGHR           /IODATA/        L*4     IODATA.INC
                HR set to AR(1) if TRUE.
                - Possibly given a new value in the following subprograms:
                  INDATA
                - Used but not changed in the following subprograms:
                  OUTDAT
CHGHRE          /IODATA/        L*4     IODATA.INC
                HRE set to HR if TRUE.
                - Possibly given a new value in the following subprograms:
                  INDATA
                - Used but not changed in the following subprograms:
                  OUTDAT
CHGHT           /IODATA/        L*4     IODATA.INC
                HT set to AT(1) if TRUE.
                - Possibly given a new value in the following subprograms:
                  INDATA
                - Used but not changed in the following subprograms:
                  OUTDAT
CHGHTE          /IODATA/        L*4     IODATA.INC
                HTE set to HT if TRUE.
                - Possibly given a new value in the following subprograms:
                  INDATA
                - Used but not changed in the following subprograms:
                  OUTDAT
CMTPFT          /CONSTA/        R*4     CONSTANTS.INC
                Meters per foot = 0.3048.
                - Used but not changed in the following subprograms:
                  ANTGEO  INDATA  UNITCV
CMTPMI          /CONSTA/        R*4     CONSTANTS.INC
                Meters per statute mile = 1609.344
                - Used but not changed in the following subprograms:
                  UNITCV
CMTPNM          /CONSTA/        R*4     CONSTANTS.INC
                Meters per nautical mile = 1852.
                - Used but not changed in the following subprograms:
                  UNITCV
CN2(NPROF)      /PROPAR/        R*4     TROCOM.INC
                The atmospheric structure constant height profile in
                meters to the -2/3 power.
                - Possibly given a new value in the following subprograms:
                  INDATA
```

```
BER(3)          /ERAD/          R*4     ERAD.INC
                Bit error rate thresholds of interest.  Set to 1E-3,
                1E-4 and 1E-5 in data statement.
                - Used but not changed in the following subprograms:
                  BERCAL  PROUT   SUMPAG
BETA0           /PATHGE/        R*4     TROCOM.INC
                Minimum receive antenna elevation angle measured from
                receiver-to-transmitter line to receiver horizon line
                in radians.
                - Possibly given a new value in the following subprograms:
                  TRANSF  UNITCV
                - Used but not changed in the following subprograms:
                  INTLIM  LOOPS   POWER   SUMPAG  TRLOSS
BETA1           /PATHGE/        R*4     TROCOM.INC
                Maximum receive antenna elevation angle measured from
                receiver-to-transmitter line to top of common volume
                in radians.
                - Possibly given a new value in the following subprograms:
                  INTLIM  UNITCV
                - Used but not changed in the following subprograms:
                  LOOPS
BOUTL(3,4)      /ERAD/          R*4     ERAD.INC
                Cumulative outage probability for each diversity
                configuration and error rate threshold (averaged
                over multipath distribution, if any).
                - Possibly given a new value in the following subprograms:
                  PROUT
BW              /SYSTRN/        R*4     TROCOM.INC
                Bandwidth in Hertz.  Default is 7 MHz.
                - Possibly given a new value in the following subprograms:
                  INDATA
                - Used but not changed in the following subprograms:
                  JAMCOM  LOOPS   MAIN    OUTDAT  POWER   SUMPAG
C               /PDATA/         R*4     PDATA.INC
                Proportionality constant in troposcatter path loss
                calculation.
                - Possibly given a new value in the following subprograms:
                  LOOPS
                - Used but not changed in the following subprograms:
                  POWER   SUMPAG
C0              /CONSTA/        R*4     CONSTANTS.INC
                Free space velocity of radio waves = 2.998E8 m/sec.
                - Used but not changed in the following subprograms:
                  INDATA  LOOPS   MDIF    POWER
CDEGR           /CONSTA/        R*4     CONSTANTS.INC
                Radians per degree = 0.017453293.
                - Used but not changed in the following subprograms:
                  DIFSNR  UNITCV
CDUR            /SYSPAR/        R*4     SYSPAR.INC
                Duration of transmitted pulse for AN/TRC-170
```

	MDTS - Used but not changed in the following subprograms: BERCAL		
AR(NRMX)	/ANTENN/	R*4	TROCOM.INC
	Array of receiver antenna diameters in meters. AR(1) is equivalent to RDIAM in the input file. - Possibly given a new value in the following subprograms: ANTGEO INDATA UNITCV - Used but not changed in the following subprograms: ANTPAR CHKDAT LOOPS OUTDAT RGAIN SUMPAG		
ASNR	/SYSPAR/	R*4	SYSPAR.INC
	Yearly median value of troposcatter short-term average SNR, ie, Eb/No, in dB. - Possibly given a new value in the following subprograms: TRCIN - Used but not changed in the following subprograms: TRC		
AT(NTMX)	/ANTENN/	R*4	TROCOM.INC
	Array of transmitter antenna diameters in meters. AT(1) is equivalent to TDIAM in the input file. - Possibly given a new value in the following subprograms: ANTGEO INDATA UNITCV - Used but not changed in the following subprograms: ANTPAR CHKDAT OUTDAT SUMPAG TGAIN		
ATTEN	/MCOM4/	R*4	MCOM.INC
	Ratio of interferer signal amplitude on antenna 2 to that at antenna 1. Set to 1 internally. - Used but not changed in the following subprograms: JAMCOM		
AVERX	/MCOM4/	R*4	MCOM.INC
	Average terrain elevation above sea level between receive site and radio horizon, in meters. - Possibly given a new value in the following subprograms: DIFSNR INDATA POWER UNITCV - Used but not changed in the following subprograms: OUTDAT		
AVETX	/MCOM4/	R*4	MCOM.INC
	Average terrain elevation above sea level between transmit site and radio horizon, in meters. - Possibly given a new value in the following subprograms: DIFSNR INDATA POWER UNITCV - Used but not changed in the following subprograms: OUTDAT		
BEAM	/STPCOM/	R*4	STPCOM.INC
	Parameter for determining azimuth and elevation angle step size in common volume integration. - Possibly given a new value in the following subprograms: STPPAR - Used but not changed in the following subprograms: STEPAB		

C.1 Global Variable Dictionary

```
A               /PATHGE/        R*4     TROCOM.INC
                Effective earth radius in meters.
                - Possibly given a new value in the following subprograms:
                  INDATA  JAMCOM
                - Used but not changed in the following subprograms:
                  INTLIM  LOOPS   LTCORR  MAIN    TRANSF
A0              /CONSTA/        R*4     CONSTANTS.INC
                Radius of the earth in meters = 6367650.
                - Used but not changed in the following subprograms:
                  INDATA  MDIF    TRANSF
AA              /PROPAR/        R*4     TROCOM.INC
                Atmospheric absorption loss in dB.
                - Possibly given a new value in the following subprograms:
                  ATMOS
                - Used but not changed in the following subprograms:
                  MAIN    POWER   SUMPAG
ABEL(4)         /ERAD/          R*4     ERAD.INC
                Cumulative block error probability for each diversity
                configuration as specified by DIVTYP (averaged over
                multipath distribution, if any).
                - Possibly given a new value in the following subprograms:
                  PROUT
ACALC           /IODATA/        L*4     IODATA.INC
                TRUE if the angles PSITEO and PSIREO are calculated
                rather than read in.
                - Possibly given a new value in the following subprograms:
                  INDATA
                - Used but not changed in the following subprograms:
                  ANTGEO  OUTDAT
ALFA0           /PATHGE/        R*4     TROCOM.INC
                Minimum transmit antenna elevation angle measured from
                transmitter-to-receiver line to transmit horizon line
                in radians.
                - Possibly given a new value in the following subprograms:
                  TRANSF  UNITCV
                - Used but not changed in the following subprograms:
                  INTLIM  LOOPS   LTCORR  POWER   SUMPAG  TRLOSS
ALFA1           /PATHGE/        R*4     TROCOM.INC
                Maximum transmit antenna elevation angle measured from
                transmitter-to-receiver line to top of common volume
                in radians.
                - Possibly given a new value in the following subprograms:
                  INTLIM  UNITCV
                - Used but not changed in the following subprograms:
                  LOOPS
APOW            /MCOM4/         R*4     MCOM.INC
                Angle diversity squint loss as a ratio.
                - Possibly given a new value in the following subprograms:
```

IBM version has been preprocessed to do the including of these files that the PDP compiler will do automatically.

The description gives the definition of the variable as well as the maximum, default value, and units where appropriate. In the case of flags all possible legal values are described. Note, the units listed are those used in TROPO for calculations and not necessarily those used for input or output.

The last two sections describe where the variable is given a new value and where it is otherwise used. These sets are mutually exclusive. A subprogram is included in the first list if the variable is used in one or more of the following:

1) on the left side of an arithmetic assignment
2) data statement
3) parameter statement (meaningful only in PDP version)
4) READ or ACCEPT statement

In addition, it may be used in one or both of the following ways, but it MUST have been used in at least one of the above. On the other hand, a subprogram is included in the second list if it is not used in one of the above but is used in one of the following:

1) on the right side of an arithmetic assignment
2) WRITE or TYPE statement

Both lists were generated by a DECUS (Digital Equipment Corporation User's Group) supplied program. Its limitations are that neither list includes:

1) use as arguments in subprogram calls
2) use in any statement when the variable is equivalenced to a common variable. The variables in common /RZ4/ are an example of this.
3) in the case of parameters, use as a dimension of an array.

For these reasons, some variables are listed as 'Not used'. They are actually used in one or more of the limitations just listed. Additionally, any variable apparently not set in any routine has either been used as an argument or has been set in the block data section (file DATAINIT.FTN).

APPENDIX C

GLOBAL VARIABLE DICTIONARY

The dictionary describes all variables in common. Each description is of the form:

```
<variable name> /<common name>/         type    <include file>
                Description.
                - Possibly given a new value in the following subprograms:
                  (List of subprograms)
                - Used but not changed in the following subprograms:
                  (List of subprograms)
```

The name is the common variable or parameter name. If the variable is a matrix, the name is followed by dimensions. In some cases these dimensions are parameters. When the PDP compiler finds such a variable in the code it replaces the parameters with their actual numeric values (as given in the file TROPAR.INC). For the IBM version, the code has already been preprocessed by SIGNATRON to use the numeric values so the actual commons will not show the parameters as dimensions but their values.

The common name is the name of the common the variable is contained in. For parameters, the word 'Parameter' is in this spot since these are not in a common.

The type, for variables and parameters, is given as three characters:

L*1	1 byte LOGICAL (BYTE in the PDP version)
L*4	4 byte LOGICAL
I*2	2 byte INTEGER
I*4	4 byte INTEGER
R*4	4 byte REAL
R*8	8 byte REAL
C*8	8 byte COMPLEX

The include file name is only meaningful to the PDP users. It is the name of the file containing the common with the variable being described. Again, the

```
        CLIMIX
       Calls the following subprgrams:
              ERROR   EXP     F1      F2      SQRT

      VARW
       Is called by the following subprograms:
              TRC
       Calls the following subprgrams:
              PROFIL  P2INT

      VDECAL
       Is called by the following subprograms:
              CLIMIL
       Calls the following subprgrams:
              EXP     F2

      XNOR
       Is called by the following subprograms:
              BERCAL  MDTS    TRC
       Calls the following subprgrams:
              DABS    DEXP    DSQRT

      YINT
       Is called by the following subprograms:
              CLIME
```

```
 Is called by the followins subprosrams:
        TROPO
 Calls the followins subprsrams:
        ABS     ASIN    ATAN    COS     ERROR   HORANG  SIN     SQRT

TRC
 Is called by the followins subprosrams:
        INDATA  TRCIN
 Calls the followins subprsrams:
        ABS     ALOG10  AVG     EIGV    PAVERG  PDFCOE  PDFSUM  POUTAG
        SQRT    SUBIO   TIMAVG  TIMEQL  TIMPAR  VARW    XNOR

TRCIN
 Is called by the followins subprosrams:
        TROPO
 Calls the followins subprsrams:
        ALOG10  ERROR   SASEQ   SUBIO   TRC

TRLOSS
 Is called by the followins subprosrams:
        LOOPS
 Calls the followins subprsrams:
        ABS     ALOG10  AMAX1   ERROR

TSINC
 Is called by the followins subprosrams:
        BOTAC   JAMCOM
 Calls the followins subprsrams:
        DABS    SINC

TXPULS
 Is called by the followins subprosrams:
        EIGV    P2INT
 Calls the followins subprsrams:
        SQRT

UNITCV
 Is called by the followins subprosrams:
        INDATA  SUMPAG
 Calls the followins subprsrams:
        ERROR

UNITS
 Is called by the followins subprosrams:
        INDATA
 Calls the followins subprsrams:
        AMOD    ERRIO

VARPOL
 Is called by the followins subprosrams:
```

SUMPAG
Is called by the following subprograms:
TROPO
Calls the following subprgrams:
ABS ALOG10 ANTPTR ERROR SIN UNITCV

TANGL
Is called by the following subprograms:
MDIF
Calls the following subprgrams:
ABS ASIN COS HORANG SIN SQRT

TGAIN
Is called by the following subprograms:
DIFSNR LOOPS
Calls the following subprgrams:
GPATT

TIMAVG
Is called by the following subprograms:
TRC
Calls the following subprgrams:
EXP INTERD

TIMEQL
Is called by the following subprograms:
TRC
Calls ne following subprgrams:
ABS TIMPAR

TIMPAR
Is called by the following subprograms:
TIMEQL TRC
Calls the following subprgrams:
PROFIL P2INT

TPSPEC
Is called by the following subprograms:
PWRSPC TPSPJ
Calls the following subprgrams:
SIN

TPSPJ
Is called by the following subprograms:
PWRSPC
Calls the following subprgrams:
EXP SQRT TPSPEC

TRANSF

```
ERR            /CONTROL/       R*4     TROCOM.INC
               Common volume integration resolution. Default is .001.
               - Possibly given a new value in the following subprograms:
                 INDATA
               - Used but not changed in the following subprograms:
                 INTLIM  LOOPS   OUTDAT  STPPAR  SUMPAG
F              /SYSTRN/        R*4     TROCOM.INC
               Operating frequency in Hz.  Model is accurate between
               100MHz and 10GHz.
               - Possibly given a new value in the following subprograms:
                 INDATA  UNITCV
               - Used but not changed in the following subprograms:
                 ANTGEO  ATMOS   DIFSNR  MAIN    OUTDAT  POWER   SUMPAG
F50L           /BUTPAR/        R*4     BUTPAR.INC
               50dB normalized corner frequency.
               - Possibly given a new value in the following subprograms:
                 FUNBW
               - Used but not changed in the following subprograms:
                 FCCMSK
FCJ            /JAMPAR/        R*4     JAMPAR.INC
               Normalized 3dB cut-off frequency of QPSK interference
               filter.
               - Possibly given a new value in the following subprograms:
                 BWJAM
               - Used but not changed in the following subprograms:
                 PSPJ    TPSPJ
FCON           /BUTPAR/        R*4     BUTPAR.INC
               Ratio of bandwidth to twice the symbol rate.
               - Possibly given a new value in the following subprograms:
                 BUTFIL  BWJAM
               - Used but not changed in the following subprograms:
                 FUNBW
FCRX           /BUTPAR/        R*4     BUTPAR.INC
               Normalized 3dB cut-off frequency of receiver filter.
               - Possibly given a new value in the following subprograms:
                 BUTFIL  BWJAM   INDATA
               - Used but not changed in the following subprograms:
                 PSPEC1  PSPEC2  PWRSPC  RJCFCN  SPEC1
FCTX           /BUTPAR/        R*4     BUTPAR.INC
               Normalized 3dB cut-off frequency of transmitter
               filter.
               - Possibly given a new value in the following subprograms:
                 BUTFIL  FUNBW   INDATA
               - Used but not changed in the following subprograms:
                 A50FCC  BWJAM   PSPJ    SPEC1   SPEC2   TPSPJ
FILLER(88)     /RZ4/           R*4     RZ4.INC
               Dummy array to align commons.
               -- Not used --
FJSEPN         /JAMPAR/        R*4     JAMPAR.INC
               Normalized frequency separation between the
```

```
                  interference signal and the desired signal.
                  - Possibly given a new value in the following subprograms:
                    BUTFIL  RJCFCN
                  - Used but not changed in the following subprograms:
                    FUNJAM  PSPEC2  PWRSPC
FMI               /JAMPAR/        R*4     JAMPAR.INC
                  Modulation index for FDM/FM interference.
                  - Possibly given a new value in the following subprograms:
                    BWJAM
                  - Used but not changed in the following subprograms:
                    PSPJ    TPSPJ
FOUTL(3,4)        /ERAD/          R*4     ERAD.INC
                  Cumulative fade outage per call minute for each
                  diversity configuration and error rate threshold
                  (averaged over multipath distribution, if any).
                  - Possibly given a new value in the following subprograms:
                    PROUT
FSEP              /PDATA/         R*4     PDATA.INC
                  Frequency separation for uncorrelated frequency
                  diversity in Hz.
                  - Possibly given a new value in the following subprograms:
                    LOOPS
                  - Used but not changed in the following subprograms:
                    SUMPAG
FT                /UNIT/          R*4     IODATA.INC
                  String 'ft  ' for units output.
                  - Used but not changed in the following subprograms:
                    OUTDAT  UNITS
GHZ               /UNIT/          R*4     IODATA.INC
                  String 'GHz ' for units output.
                  - Used but not changed in the following subprograms:
                    INDATA  OUTDAT  UNITS
GPF               /CURVE/         R*4     CURVE.INC
                  Frequency correction factor for user supplied 90th
                  percentile variability curve.  Default is 1.
                  - Possibly given a new value in the following subprograms:
                    INDATA
                  - Used but not changed in the following subprograms:
                    CLIME
GRDB(NRMX)        /ANTENN/        R*4     TROCOM.INC
                  Gain of each receive antenna in dBi.
                  - Possibly given a new value in the following subprograms:
                    MAIN
                  - Used but not changed in the following subprograms:
                    DIFSNR  POWER   SUMPAG
GTDB(NTMX)        /ANTENN/        R*4     TROCOM.INC
                  Gain of each transmit antenna in dBi.
                  - Possibly given a new value in the following subprograms:
                    MAIN
                  - Used but not changed in the following subprograms:
```

```
                     DIFSNR  POWER   SUMPAG
HCOM             /PATHGE/        R*4     TROCOM.INC
                 Effective height of the bottom of the common volume in
                 meters.
                 - Possibly given a new value in the following subprograms:
                   LOOPS   TRANSF  UNITCV
                 - Used but not changed in the following subprograms:
                   LTCORR  SUMPAG
HHIGH            /PATHGE/        R*4     TROCOM.INC
                 Effective height of the top of the common volume in
                 meters.
                 - Possibly given a new value in the following subprograms:
                   INTLIM  UNITCV
                 - Used but not changed in the following subprograms:
                   SUMPAG
HI(155)          /MCOM4/         R*4     MCOM.INC
                 Array containing NPM(1) evenly-spaced terrain
                 elevation data (in meters) between transmitter and
                 first obstacle followed by NPM(2) evenly-spaced
                 terrain elevation data between first and second
                 obstacle, etc., ending with NPM(NOBS+1) evenly-spaced
                 terrain elevation data between last obstacle and
                 receive site. The data should be selected such that:
                         HI(1) = Terrain elevation above sea level at
                                  transmit site (HTO).
                         HI(NPM(I)) = HI (NPM(I)+1) = Elevation of Ith
                                  obstacle above sea level (HL(I)).
                         HI(NPM(NOBS+1)) = Terrain elevation above sea
                                  level at receive site (HRO).
                 In MDTS, HI is used as work space.  It is equivalenced
                 to local arrays.
                 - Possibly given a new value in the following subprograms:
                   INDATA  UNITCV
                 - Used but not changed in the following subprograms:
                   DIFSNR  OUTDAT  POWER
HL(3)            /MCOM4/         R*4     MCOM.INC
                 Array containing elevation of each obstacle above sea
                 level in meters.  HL(1) is elevation of transmitter
                 radio horizon HLT.  HL(NOBS) is elevation of receiver
                 radio horizon HLR.
                 - Possibly given a new value in the following subprograms:
                   INDATA  UNITCV
                 - Used but not changed in the following subprograms:
                   DIFSNR  MAIN    OUTDAT
HLAV(3)          /MCOM4/         R*4     MCOM.INC
                 Array containing average terrain elevation at each
                 diffraction point in meters.
                 - Possibly given a new value in the following subprograms:
                   INDATA  UNITCV
                 - Used but not changed in the following subprograms:
```

```
                   DIFSNR  OUTDAT
HLEF(3)          /MCOM4/         R*4     MCOM.INC
                 Array containing effective height of obstacles above
                 average terrain elevation in meters.
                 - Possibly given a new value in the following subprograms:
                   INDATA  UNITCV
                 - Used but not changed in the following subprograms:
                   DIFSNR  OUTDAT
HLOW             /PROPAR/        R*4     TROCOM.INC
                 Lowest height above sea level at which CN2 is
                 specified in meters.
                 - Possibly given a new value in the following subprograms:
                   INDATA  UNITCV
                 - Used but not changed in the following subprograms:
                   LOOPS   OUTDAT
HLR              /PATHGE/        R*4     TROCOM.INC
                 Receiver radio horizon elevation above sea level in
                 meters.
                 - Possibly given a new value in the following subprograms:
                   INDATA  TRANSF  UNITCV
                 - Used but not changed in the following subprograms:
                   OUTDAT  SUMPAG
HLT              /PATHGE/        R*4     TROCOM.INC
                 Transmit radio horizon elevation above sea level in
                 meters.
                 - Possibly given a new value in the following subprograms:
                   INDATA  TRANSF  UNITCV
                 - Used but not changed in the following subprograms:
                   OUTDAT  SUMPAG
HRE              /MCOM4/         R*4     MCOM.INC
                 Effective receiver antenna height above average
                 terrain elevation in meters.
                 - Possibly given a new value in the following subprograms:
                   INDATA  POWER   UNITCV
                 - Used but not changed in the following subprograms:
                   DIFSNR
HRN              /PATHGE/        R*4     TROCOM.INC
                 Receive antenna height above sea level in meters.
                 - Possibly given a new value in the following subprograms:
                   INDATA  TRANSF  UNITCV
                 - Used but not changed in the following subprograms:
                   DIFSNR  INTLIM  JAMCOM  LTCORR  MAIN   OUTDAT  POWER   SUMPAG
HTE              /MCOM4/         R*4     MCOM.INC
                 Effective transmitter antenna height above average
                 terrain elevation in meters.
                 - Possibly given a new value in the following subprograms:
                   INDATA  POWER   UNITCV
                 - Used but not changed in the following subprograms:
                   DIFSNR  OUTDAT
HTN              /PATHGE/        R*4     TROCOM.INC
```

Transmit antenna height above sea level in meters.
- Possibly given a new value in the following subprograms:
  INDATA TRANSF UNITCV
- Used but not changed in the following subprograms:
  DIFSNR INTLIM LOOPS MAIN OUTDAT POWER SUMPAG

I1CORR(NCORMX) /PDATA/ I*2 PDATA.INC
Array of receiving beams involved in the correlation calculations.
- Possibly given a new value in the following subprograms:
  LOOPS
- Used but not changed in the following subprograms:
  SIM SUMPAG

I2CORR(NCORMX) /PDATA/ I*2 PDATA.INC
Array of receiving beams involved in the correlation calculations.
- Possibly given a new value in the following subprograms:
  LOOPS
- Used but not changed in the following subprograms:
  SIM SUMPAG

IBLOSS(6) /CPLOSS/ I*2 CPL.INC
Beam number corresponding to CPL(I).
- Possibly given a new value in the following subprograms:
  LOOPS
- Used but not changed in the following subprograms:
  POWER

IBR(NRMX,NRMX) /SYSTRN/ I*2 TROCOM.INC
Channel complex-envelope correlation and cross-correlation calculation indicator array.
  0 = No calculation
  1 = Power (correlation) calculation only
  2 = Power (correlation) per unit delay spectrum calculation
- Possibly given a new value in the following subprograms:
  ANTGEO INDATA
- Used but not changed in the following subprograms:
  CHKDAT LOOPS OUTDAT STPPAR SUMPAG

IBW /MCOM2/ I*2 MCOM.INC
Switch indicating type of RF bandwidth constraint to be used on desired signal. Default is 0.
  0 = No RF filtering
  1 = Filter determined from 99% bandwidth constraint
  2 = Filter chosen to meet FCC Mask. (FCC-19311)
  3 = Filters are user specified
- Possibly given a new value in the following subprograms:
  INDATA
- Used but not changed in the following subprograms:
  BOTAC MAIN MDTS OUTDAT SIGIN

ICHIP(30) /SYSPAR/ I*2 SYSPAR.INC
PN sequence for spectrum spreading when the data rate is much smaller than the bandwidth.

```
                - Possibly given a new value in the following subprograms:
                  TRCIN
                - Used but not changed in the following subprograms:
                  TRC     TXPULS
ICLIME          /MCOM2/         I*2     MCOM.INC
                Climate class.  Default is 0.
                   0 = NBS TN-101 climate
                   1 = MIL-HDBK-417 climate
                   2 = New, user-supplied climate
                - Possibly given a new value in the following subprograms:
                  INDATA
                - Used but not changed in the following subprograms:
                  OUTDAT  SUMPAG
ICON            /BUTPAR/        I*2     BUTPAR.INC
                   1 = 99% bandwidth constraint
                   2 = FCC-13911 bandwidth constraint
                - Possibly given a new value in the following subprograms:
                  BUTFIL  BWJAM
                - Used but not changed in the following subprograms:
                  FUNBW
ICORR           /MCOM2/         I*2     MCOM.INC
                Multipath profile correlation indicator.  Default
                is 2.
                   0 = Profile of the form X * exp(-A*X) -- used for
                       debugging
                   1 = Computed multipath profile; no beam correlation
                   2 = Computed multipath profile; beam correlation.
                - Used but not changed in the following subprograms:
                  CAC     DINT    MDTS    SIGIN
ICPL            /CPLOSS/        I*2     CPL.INC
                Coupling loss count.
                - Possibly given a new value in the following subprograms:
                  LOOPS
                - Used but not changed in the following subprograms:
                  POWER   TRLOSS
IDM             /UNIT/          I*2     IODATA.INC
                0 if degrees, 1 if milliradians.
                - Possibly given a new value in the following subprograms:
                  UNITS
                - Used but not changed in the following subprograms:
                  UNITCV
IFILE           /MCOM2/         I*2     MCOM.INC
                Pointer to multipath profile.
                - Possibly given a new value in the following subprograms:
                  MATCO   MDTS
                - Used but not changed in the following subprograms:
                  CAC
IFILRX          /BUTPAR/        I*2     BUTPAR.INC
                Receiver filter indicator.
                        0 = MD-918 receiver filter.  Also means
```

```
                         filter is a Butterworth cascaded with a
                         rectangular impulse response filter of
                         duration equal to symbol duration.
                     1 = (not allowed)
                     2 = AN/TRC-170 receiver filter.  Also means
                         filter is a Butterworth.
               - Possibly given a new value in the following subprograms:
                 BUTFIL  INDATA
               - Used but not changed in the following subprograms:
                 FUNJAM  PSPEC1  PSPEC2  PWRSPC  SPEC1
IFILTX         /BUTPAR/        I*2     BUTPAR.INC
               Transmitter filter indicator.
                     0 = MD-918 transmitter filter.  Also means
                         filter is a Butterworth cascaded with a
                         rectangular impulse response filter of
                         duration equal to symbol duration.
                     1 = AN/TRC-170 transmitter filter.  Also means
                         filter is a cascade of Butterworth filter
                         with rectangular impulse response filter
                         of duration equal to half symbol duration.
                     2 = (not allowed)
               - Possibly given a new value in the following subprograms:
                 BUTFIL  INDATA
               - Used but not changed in the following subprograms:
                 A5OFCC  BWJAM   FUNBW   PSPJ    SPEC1   SPEC2   TPSPJ
IME            /UNIT/          I*2     IODATA.INC
               0 if metric units, 1 if English.
               - Possibly given a new value in the following subprograms:
                 UNITS
               - Used but not changed in the following subprograms:
                 UNITCV
IMG            /UNIT/          I*2     IODATA.INC
               0 if MHz, 1 if GHz.
               - Possibly given a new value in the following subprograms:
                 UNITS
               - Used but not changed in the following subprograms:
                 UNITCV
INEG           /PDATA/         I*2     PDATA.INC
               Number of negative delay cells encountered in
               troposcatter integration.  It is an error if INEG > 0.
               - Possibly given a new value in the following subprograms:
                 LOOPS
               - Used but not changed in the following subprograms:
                 SUMPAG
INS            /UNIT/          I*2     IODATA.INC
               0 if nautical miles, 1 if statute miles.
               - Possibly given a new value in the following subprograms:
                 UNITS
               - Used but not changed in the following subprograms:
                 UNITCV
```

```
IOPEND          /CONTRL/        I*2     TROCOM.INC
                Number of output files opened.
                - Possibly given a new value in the following subprograms:
                  INDATA  SUMPAG
IOPERF          /IOUT/          I*2     IOUT.INC
                Switch for calculation of performance of AN/TRC-170.
                        0 = ABER and outage probability
                        1 = ABER (average bit error rate) only
                        2 = Outage probability only
                Set to 0 internally.
                - Possibly given a new value in the following subprograms:
                  TRCIN
                - Used but not changed in the following subprograms:
                  TRC
IOTIME          /IOUT/          I*2     IOUT.INC
                Switch for calculation of performance of AN/TRC-170.
                        0 = Short term performance assuming various
                            sampling times.
                        1 = Short term performance assuming Gaussian
                            timing jitter.
                        2 = Yearly average performance assuming
                            Gaussian timing jitter.
                Set to 2 internally.
                - Possibly given a new value in the following subprograms:
                  TRCIN
                - Used but not changed in the following subprograms:
                  TRC
IPOLR(NRMX)     /ANTENN/        I*2     TROCOM.INC
                Array of receiver antenna polarizations.
                - Possibly given a new value in the following subprograms:
                  ANTGEO  INDATA
                - Used but not changed in the following subprograms:
                  LOOPS   OUTDAT  STPPAR  SUMPAG
IPOLT(NTMX)     /ANTENN/        I*2     TROCOM.INC
                Array of transmitter antenna polarizations.
                - Possibly given a new value in the following subprograms:
                  ANTGEO  INDATA
                - Used but not changed in the following subprograms:
                  LOOPS   OUTDAT  SUMPAG
IPOS            /PDATA/         I*2     PDATA.INC
                Number of delay cells exceeding the last allocated
                array element.  This number should be zero or small.
                IPOS > 0 is not a serious error unless the delay
                profile calculated has a clear peak in the last delay
                cell.
                - Possibly given a new value in the following subprograms:
                  LOOPS
                - Used but not changed in the following subprograms:
                  SUMPAG
IPROF(NCORMX)   /PDATA/         I*2     PDATA.INC
```

0 if the Ith correlation not wanted, 1 if wanted.
- Possibly given a new value in the following subprograms:
  LOOPS
- Used but not changed in the following subprograms:
  SIM SUMPAG

IPROFL /SYSPAR/ I*2 SYSPAR.INC
Parameter that indicates whether troposcatter power per unit delay profile of the form X exp (-A*X) is to be used (IPROFL = 0) or not. Set to zero in TRCIN.
- Possibly given a new value in the following subprograms:
  TRCIN
- Used but not changed in the following subprograms:
  EIGV TIMPAR TRC VARW

IPULS /SYSPAR/ I*2 SYSPAR.INC
Switch to indicate whether pulse shape at input of the AN/TRC-170 detector includes the effects of RF filters (IPULS = 2) or not (IPULS = 0 or 1). Set to 2 internally. If IBW is 0, set to 1.
- Possibly given a new value in the following subprograms:
  TRCIN
- Used but not changed in the following subprograms:
  P2INT TRC TXPULS

IRF /PATHGE/ I*2 TROCOM.INC
Parameter which indicates whether reference horizon elevation angles have been calculated (IRF = 1) in previous run. It has meaning only when ITOFF = 3.
- Possibly given a new value in the following subprograms:
  TRANSF

IRSN /NUMPAR/ I*2 NUMPAR.INC
Number of values in SNR array RSNRSN(30). Used to calculate ISI statistics for AN/TRC-170. Initially set to 30.
- Used but not changed in the following subprograms:
  POUTAG

ISN /IOUT/ I*2 IOUT.INC
Number of SNR values for which short-term performance of AN/TRC-170 is to be performed. Set to 17.
- Possibly given a new value in the following subprograms:
  TRCIN
- Used but not changed in the following subprograms:
  TRC

IT /IOUT/ I*2 IOUT.INC
Number of different sampling times to be used in calculation of AN/TRC-170 short term performance.
- Used but not changed in the following subprograms:
  TRC

ITER /PDATA/ I*4 PDATA.INC
Number of integration cells in the common volume integration.
- Possibly given a new value in the following subprograms:

```
                  LOOPS
                - Used but not changed in the following subprograms:
                  POWER   SUMPAG
ITOFF           /PROPAR/        I*2     TROCOM.INC
                Control indicator for entry or calculation of
                transmit/receive radio horizon angles THET and THER.
                Values have following meanings:
                        0 = Use input THET, THER as reference and
                            actual horizon (default).
                        1 = Calculate reference horizon using HORANG
                            and K equals 1.33.  (Assuming DLT and DLR
                            are non-zero.)  (Option not available.)
                        2 = Calculate reference horizon using HORANG
                            and K equals ERFAC.  (Assuming DLT and DLR
                            are non-zero.)
                        3 = Do not change reference horizons from
                            previous run.  (Option not available.)
                - Possibly given a new value in the following subprograms:
                  INDATA  MAIN    OUTDAT
                - Used but not changed in the following subprograms:
                  TRANSF
JBW             /JAMPAR/        R*4     JAMPAR.INC
                99% interferer bandwidth in MHz.
                - Possibly given a new value in the following subprograms:
                  BUTFIL
                - Used but not changed in the following subprograms:
                  BWJAM
JFILT           /MCOM2/         I*2     MCOM.INC
                Interference covariance matrix calculation indicator.
                Only used when IBW equals 0, otherwise ignored.
                Default is 0.
                        0 = Interferer covariance matrix calculation
                            done in subroutine BOTAC
                        1 = Interferer covariance matrix calculation
                            done in subroutine JAMCOM
                - Used but not changed in the following subprograms:
                  BOTAC   OUTDAT
JPOW            /JAMPAR/        R*4     JAMPAR.INC
                Interferer power density in dBm/Hz: -174 or less
                denotes no interference.  Default is -1000 dBm/Hz.
                - Possibly given a new value in the following subprograms:
                  BUTFIL
                - Used but not changed in the following subprograms:
                  BWJAM
JQ2M            /MCOM4/         I*2     MCOM.INC
                Pointer to centroid of lower beam troposcatter signal
                power per unit delay profile.
                - Possibly given a new value in the following subprograms:
                  POWER
                - Used but not changed in the following subprograms:
```

```
                  CAC     DINT
JREFL           /MCOM2/         I*2     MCOM.INC
                Indicates whether specular reflection is to be
                included in interferer covariance matrix calculation
                (JREFL = 1) or not (JREFL = 0).  Default is 0.
                - Used but not changed in the following subprograms:
                  JAMCOM
KGAIN           /RZ/            I*2     RZ.INC
                Integer ratio of bandwidth to data rate.
                - Possibly given a new value in the following subprograms:
                  POWER
                - Used but not changed in the following subprograms:
                  CAC     DINT    MDTS    SASEQ   SIGIN   SINT    TRCIN
KISI            /NUMPAR/        I*2     NUMPAR.INC
                Parameter for calculation of AN/TRC-170 outage
                probability.  Set to 6 in data statement.
                - Used but not changed in the following subprograms:
                  POUTAG  TRC
KLIMAT          /PROPAR/        I*2     TROCOM.INC
                Climate zone indicator.  Default is 0.
                        0 = User supplied climate
                NBS TN101 climates
                        1 = Continental temperate (CT)
                        2 = Maritime temperate overland (MTL)
                        3 = Maritime temperate oversea (MTS)
                        4 = Maritime subtropical overland (MSL)
                        5 = Continental temperate time block 2 (CT2)
                            (winter afternoon hours) - formerly
                            Maritime subtropical oversea (MSS)
                        6 = Desert, Sahara (DS)
                        7 = Equatorial (EQU)
                        8 = Continental subtropical (CS)
                MIL-HDBK-417 climates
                        9 = Continental temperate (CT)
                        10 = Maritime temperate overland (MTL)
                        11 = Maritime temperate oversea (MTS)
                        12 = Maritime subtropical (MS)
                        13 = Desert, Sahara (DS)
                        14 = Equatorial (EQU)
                        15 = Continental subtropical (CS)
                        16 = Mediterranean (MED)
                        17 = Polar (POL)
                - Possibly given a new value in the following subprograms:
                  INDATA
                - Used but not changed in the following subprograms:
                  AVAIL   POWER
KM              /UNIT/          R*4     IODATA.INC
                String 'km  ' for units output.
                - Used but not changed in the following subprograms:
                  INDATA  OUTDAT  UNITS
```

```
ROF            /PROPAR/        I*2     TROCOM.INC
               Actual number of samples in height profile of
               structure constant CN2.  Limited to NPROF samples.
               - Possibly given a new value in the following subprograms:
                 INDATA
               - Used but not changed in the following subprograms:
                 LOOPS   OUTDAT  RIPROF
NG             /MCOM2/         I*2     MCOM.INC
               Pointer to data array elements containing interferer
               azimuth and elevation angles.
               - Possibly given a new value in the following subprograms:
                 MDTS
               - Used but not changed in the following subprograms:
                 JAMCOM
EBUG           /LUNS/          I*2     LUNS.INC
               Debug output unit.  Always the same as LOUT but used
               to uniquely identify the write statements.
               - Used but not changed in the following subprograms:
                 MATCO
RR             /LUNS/          I*2     LUNS.INC
               Error output unit.
               - Used but not changed in the following subprograms:
                 ANTGEO  BUTFIL  BWJAM   CLIME   CLIMIL  CLIMIX  CONVOL  DEIND
                 DIFSNR  DIF1    INDATA  LTCORR  MDIF    MDTS    ORDER   POWER
                 SEARCH  SECTOR  SIGIN   TANGL   TRC     UNITS
N              /LUNS/          I*2     LUNS.INC
               TROPO.DAT input unit number.
               - Possibly given a new value in the following subprograms:
                 INDATA  SECTOR  UNITS
NKNO           /IODATA/        I*2     IODATA.INC
               Link number.
               - Possibly given a new value in the following subprograms:
                 INDATA
               - Used but not changed in the following subprograms:
                 SUMPAG
SI             /MCOM2/         I*2     MCOM.INC
               Number of future Intersymbol Interference (ISI)
               contributors considered in MD-918 performance
               calculation.  Default is 2.
               - Possibly given a new value in the following subprograms:
                 INDATA  SIGIN
               - Used but not changed in the following subprograms:
                 MATCO   OUTDAT
IAME(20)       /IODATA/        I*2     IODATA.INC
               Link name.  Transmitter site first, receiver site
               second.  Used as link identifier on output files
               FOR002.DAT and SUMPAG.OUT.
               - Possibly given a new value in the following subprograms:
                 INDATA
               - Used but not changed in the following subprograms:
```

```
                OUTDAT  SUMPAG
T             /LUNS/          I*2     LUNS.INC
              FOR002.DAT output unit number.
              - Used but not changed in the following subprograms:
                AVAIL   BERCAL  BOTAC   BUTFIL  CLIFIT  CLIMIX  DIFSNR  ERRIO
                ERROR   MAIN    MATCO   MDIF    MDTS    OUTDAT  POWER   PROUT
                SASEQ   SIM     SINT    SUBID   TRC     TRCIN
M             /LUNS/          I*2     LUNS.INC
              SUMPAG.OUT output unit number.
              - Used but not changed in the following subprograms:
                SUMPAG
ITS           /UNIT/          I*2     IODATA.INC
              Integer value that specifies the set of units
              requested by the user.  These units are for path,
              antenna location, angle, and frequency parameters.
              Default is 8.  The given units are defined by bit
              values of LUNITS:
              Bit no.         Meaning of value 0 / 1
                0             english / metric
                1             statute miles / nautical miles
                2             feet / meters
                3             mrad / degrees
                4             GHz / MHz
              Valid LUNITS values are
              0 :    stat. miles  - feet   - milliradians - GHz
              1 :    kilometers   - meters - milliradians - GHz
              2 :    naut. miles  - feet   - milliradians - GHz
              8 :    stat. miles  - feet   - degrees      - GHz
              9 :    kilometers   - meters - degrees      - GHz
              10:    naut.miles   - feet   - degrees      - GHZ
              16:    stat. miles  - feet   - milliradians - MHz
              17:    kilometers   - meters - milliradians - MHz
              18:    naut. miles  - feet   - milliradians - MHz
              24:    stat. miles  - feet   - degrees      - MHz
              25:    kilometers   - meters - degrees      - MHz
              26:    naut. miles  - feet   - degrees      - MHz
              - Possibly given a new value in the following subprograms:
                UNITS
              - Used but not changed in the following subprograms:
                OUTDAT  SUMPAG  UNITCV
G             /MCOM2/         I*2     MCOM.INC
              Number of values of interferer azimuth/elevation pairs
              (JANG) for which outage calculations are to be made.
              Default is 1.
              - Possibly given a new value in the following subprograms:
                INDATA
              - Used but not changed in the following subprograms:
                MDTS    OUTDAT
ST            /ERAD/          I*2     ERAD.INC
              Multipath distribution indicator.
```

```
            0 = Only median multipath spread used(default)
            1 = Multipath distribution used.  (Option not
                currently available.)
    - Used but not changed in the following subprograms:
      INDATA  MAIN    POWER   PROUT
    /UNIT/          R*4     IODATA.INC
    String 'met ' for units output.
    - Used but not changed in the following subprograms:
      ANTGEO  OUTDAT  UNITS
    /UNIT/          R*4     IODATA.INC
    String 'MHz ' for units output.
    - Used but not changed in the following subprograms:
      ANTGEO  INDATA  OUTDAT  UNITS
    /PDATA/         I*2     PDATA.INC
    Number of simulator taps.  Default is 16.
    - Possibly given a new value in the following subprograms:
      INDATA
    - Used but not changed in the following subprograms:
      SIM
iT  /MCOM2/         I*2     MCOM.INC
    Propagation/modem flag to select calculation mode.
    Default is 1.
            0 = Propagation only
            1 = Propagation + MD-918 modem
            2 = Propagation + AN/TRC-170 or DAR modem
            3 = Propagation + user-defined modem
    - Possibly given a new value in the following subprograms:
      INDATA  POWER
    - Used but not changed in the following subprograms:
      MAIN    OUTDAT  SUMPAG
;   /JAMPAR/        I*2     JAMPAR.INC
    Interference signal modulation format.  Default is 1.
            0 = Analog FDM / FM
            1 = Digital QPSK
    - Possibly given a new value in the following subprograms:
      BUTFIL
    - Used but not changed in the following subprograms:
      BWJAM   PSPJ    TPSPJ
iG  /MCOM2/         I*2     MCOM.INC
    Interference signal modulation format.  Default is 1.
            0 = Analog FDM / FM
            1 = Digital QPSK
    - Possibly given a new value in the following subprograms:
      INDATA
    - Used but not changed in the following subprograms:
      MAIN    OUTDAT  SUMPAG
    /ERAD/          I*2     ERAD.INC
    Loop limit for MRAD. Default is 1.
    (MRAD is 1 for MDIST = 0 and MRAD is 3 for MDIST = 1).
    - Possibly given a new value in the following subprograms:
```

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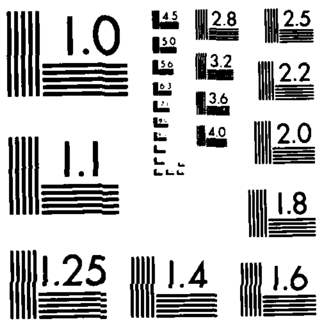

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```
                            INDATA
                          - Used but not changed in the following subprograms:
                            MAIN
        MRADNS            /UNIT/          R*4     IODATA.INC
                          String 'mrad' for units output.
                          - Used but not changed in the following subprograms:
                            ANTGEO  OUTDAT  UNITS
        NACCU             /CONTRL/        I*2     TROCOM.INC
                          Parameter used as truncation point for common
                          volume integration termination.  Default is 40.
                          - Possibly given a new value in the following subprograms:
                            INDATA
                          - Used but not changed in the following subprograms:
                            LOOPS   OUTDAT  SUMPAG
        NANG              /RI2/           I*2     RI2.INC
                          NANG is 1 if there is angle diversity (default).
                          - Possibly given a new value in the following subprograms:
                            INDATA
                          - Used but not changed in the following subprograms:
                            MDTS
        NB                /RI2/           I*2     RI2.INC
                          Number of elements accessed in arrays DU, DX and DY.
                          - Used but not changed in the following subprograms:
                            CAJI
        NCHIP             /SYSPAR/        I*2     SYSPAR.INC
                          Number of chips in PN sequence used to expand
                          bandwidth in AN/TRC-170.
                          - Possibly given a new value in the following subprograms:
                            TRCIN
                          - Used but not changed in the following subprograms:
                            P2INT   TRC     TXPULS
        NCLIME            /MCOM2/         I*2     MCOM.INC
                          Flag set to 1 if ICLIME equals 2.
                          - Possibly given a new value in the following subprograms:
                            INDATA
                          - Used but not changed in the following subprograms:
                            OUTDAT
        NCORMX            Parameter       I*2     TROPAR.INC
                          Maximum number of correlations between receive ports.
                          - Used but not changed in the following subprograms:
                            LOOPS   SIM
        NCORR             /PDATA/         I*2     PDATA.INC
                          Number of receive port correlations.
                          - Possibly given a new value in the following subprograms:
                            LOOPS
                          - Used but not changed in the following subprograms:
                            POWER   SIM     SUMPAG
        NDELMX            Parameter       I*2     TROPAR.INC
                          Maximum number of delay bins in troposcatter power per
                          unit delay profiles.
```

```
                - Used but not changed in the following subprograms:
                  LOOPS   MDIF    POWER   SIM     SUMPAG
NDELQ           /MCOM4/        I*2    MCOM.INC
                Number of non-zero elements of troposcatter power per
                unit delay profiles Q(NDELQ,1).
                - Possibly given a new value in the following subprograms:
                  POWER
                - Used but not changed in the following subprograms:
                  CAC     DINT
NDIVS           /SYSPAR/       I*2    SYSPAR.INC
                Number of explicit diversity channels for AN/TRC-170.
                Equal to 4 for 2S/2F and 2 for 2S or 2F.
                - Possibly given a new value in the following subprograms:
                  TRCIN
                - Used but not changed in the following subprograms:
                  AVG     TRC     VARW
NEIGEN          /ANSWER/       I*2    ANSWER.INC
                Number of implicit diversity eigenvalues (stored in
                array VEIGV) used in calculation of AN/TRC-170
                performance.
                - Possibly given a new value in the following subprograms:
                  EIGV
                - Used but not changed in the following subprograms:
                  AVG     TRC
NERT            /MCOM2/        I*2    MCOM.INC
                Bit error rate threshold indicator for yearly fade
                outage probability calculation.  Default is 2.
                        0 = All three thresholds
                        1 = For 10**(-3) only
                        2 = For 10**(-4) only
                        3 = For 10**(-5) only
                - Possibly given a new value in the following subprograms:
                  INDATA
                - Used but not changed in the following subprograms:
                  BERCAL  MAIN    MDTS    OUTDAT  SUMPAG
NEWCL(4)        /MCOM2/        I*2    MCOM.INC
                New climate type character string.
                - Possibly given a new value in the following subprograms:
                  INDATA
                - Used but not changed in the following subprograms:
                  OUTDAT  SUMPAG
NFIG            /MCOM4/        R*4    MCOM.INC
                Receiver noise figure in dB.  Default is 4dB.
                - Possibly given a new value in the following subprograms:
                  INDATA
                - Used but not changed in the following subprograms:
                  DIFSNR  OUTDAT  POWER
NIP             /RZ/           I*2
                Initialization constant for numerical equalizer
                covariance matrix calculation.
```

- Possibly given a new value in the following subprograms:
  MDTS
- Used but not changed in the following subprograms:
  CAC

NJR /RZ4/ I*2 RZ4.INC
Number of sample points for RJCOR.
- Possibly given a new value in the following subprograms:
  BUTFIL
- Used but not changed in the following subprograms:
  BOTAC

NMI /UNIT/ R*4 IODATA.INC
String 'nmi ' for units output.
- Used but not changed in the following subprograms:
  OUTDAT UNITS

NOBS /MCOM2/ I*2 MCOM.INC
Number of diffraction obstacles. Maximum is 3, default is 1.
- Possibly given a new value in the following subprograms:
  INDATA
- Used but not changed in the following subprograms:
  DIFSNR MAIN OUTDAT POWER

NOW(8) /TSTAMP/ L*1 IODATA.INC
Array used in PDP-11/70 version to hold time of day as characters.
- Used but not changed in the following subprograms:
  MAIN OUTDAT SUMPAG

NPM(5) /MCOM2/ I*2 MCOM.INC
Array containing number of terrain elevation data points for calculation of effective antenna heights for each section of the diffraction path.
- Possibly given a new value in the following subprograms:
  INDATA
- Used but not changed in the following subprograms:
  DIFSNR OUTDAT POWER

NPOINT /NUMPAR/ I*2 NUMPAR.INC
Number of points for numerical integration.
- Used but not changed in the following subprograms:
  TRC

NPOLJ /JAMPAR/ I*2 JAMPAR.INC
Number of poles in the QPSK interference filter.
- Possibly given a new value in the following subprograms:
  BWJAM
- Used but not changed in the following subprograms:
  PSPJ TPSPJ

NPOLRX /BUTPAR/ R*4 BUTPAR.INC
Number of poles in the receive Butterworth filter.
- Possibly given a new value in the following subprograms:
  BWJAM INDATA SEARCH
- Used but not changed in the following subprograms:
  BUTFIL FUNJAM PSPEC1 PSPEC2 PWRSPC SPEC1

```
NPOLTX        /BUTPAR/       I*2     BUTPAR.INC
              Number of poles in the transmit Butterworth filter.
              - Possibly given a new value in the following subprograms:
                BWJAM   INDATA  SEARCH
              - Used but not changed in the following subprograms:
                A50FCC  BUTFIL  FUNBW   PSPJ    SPEC1   SPEC2   TPSPJ
NPROF         Parameter      I*2     TROPAR.INC
              Dimension of array containing the structure constant
              height profile (CN2).
              -- Not used --
NR            /SYSTRN/       I*2     TROCOM.INC
              Number of receive ports.
              - Possibly given a new value in the following subprograms:
                ANTGEO  INDATA
              - Used but not changed in the following subprograms:
                CHKDAT  INTLIM  LOOPS   MAIN    OUTDAT  STPPAR  SUMPAG  TRANSF
                UNITCV
NRAD          /ERAD/         I*2     ERAD.INC
              ERFAC indicator and loop counter.  Default is 1.
              - Used but not changed in the following subprograms:
                MAIN    POWER   PROUT
NRMX          Parameter      I*2     TROPAR.INC
              Maximum number of receive ports.
              - Used but not changed in the following subprograms:
                ANTPAR  CHKDAT
NT            /SYSTRN/       I*2     TROCOM.INC
              Number of transmit ports.
              - Possibly given a new value in the following subprograms:
                ANTGEO  INDATA
              - Used but not changed in the following subprograms:
                CHKDAT  INTLIM  LOOPS   MAIN    OUTDAT  STPPAR  SUMPAG  TRANSF
                UNITCV
NTAP          /MCOM2/        I*2     MCOM.INC
              Number of adaptive forward equalizer taps (AFE) in
              MD-918 modem.  Set to 3 in INDATA.
              - Used but not changed in the following subprograms:
                OUTDAT  SIGIN
NTERR         /MCOM2/        I*2     MCOM.INC
              Control parameter for entry or calculation of
              effective antenna heights (HTE, HRE) and effective
              obstacle heights above average terrain elevation
              (HLEF).
                      0 = HTE and HRE supplied directly
                      1 = AVETX and AVERX supplied
                      2 = HI(.) supplied
              - Possibly given a new value in the following subprograms:
                INDATA
              - Used but not changed in the following subprograms:
                DIFSNR  OUTDAT  POWER
NTH1          /IOUT/         I*2     IOUT.INC
```

```
                    Pointer to largest bit error rate threshold of
                    interest for AN/TRC-170 outage probability
                    calculation.
                    - Possibly given a new value in the following subprograms:
                      TRCIN
                    - Used but not changed in the following subprograms:
                      TRC
NTH2                /IOUT/          I*2     IOUT.INC
                    Pointer to smallest bit error rate threshold of
                    interest for AN/TRC-170 outage probability
                    calculation.
                    - Possibly given a new value in the following subprograms:
                      TRCIN
                    - Used but not changed in the following subprograms:
                      TRC
NTHR                /SYSPAR/        I*2     SYSPAR.INC
                    Pointer to bit error rate threshold for AN/TRC-170
                    outage probability calculation.
                    - Used but not changed in the following subprograms:
                      POUTAG  TRC     TRCIN
NTMX                Parameter       I*2     TROPAR.INC
                    Maximum number of transmit ports.
                    - Used but not changed in the following subprograms:
                      ANTPAR  CHKDAT
NTR                 /RZ4/           I*2     RZ4.INC
                    Number of samples for calculating transmit-receive
                    filter impulse response (TRFILT).
                    - Used but not changed in the following subprograms:
                      BUTFIL  CAC     TXPULS
NUMVC               /SYSTRN/        I*2     TROCOM.INC
                    Number of voice channels in analog troposcatter
                    system.  Default is 72.
                    -- Not used --
NV                  /NUMPAR/        I*2     NUMPAR.INC
                    Normalization parameter for calculation of AN/TRC-170
                    signal gain.  Set to 18.
                    - Used but not changed in the following subprograms:
                      TRC
PAVG(20,20)         /ANSWER/        R*4     ANSWER.INC
                    Short-term average bit error rate for each sampling
                    time and short-term average SNR.
                    - Possibly given a new value in the following subprograms:
                      TRC
PCON                /RZ/            R*8     RZ.INC
                    Normalization factor for probability integral.
                    - Possibly given a new value in the following subprograms:
                      MDTS
                    - Used but not changed in the following subprograms:
                      CAC
PDUR                /SYSPAR/        R*4     SYSPAR.INC
```

```
                    Symbol pulse duration.
                    - Possibly given a new value in the following subprograms:
                      TRC
                    - Used but not changed in the following subprograms:
                      P2INT   TXPULS
PEAKAV              /RZ4/           R*4     RZ4.INC
                    Peak-to-average loss due to RF filtering in dB.
                    - Possibly given a new value in the following subprograms:
                      BUTFIL  MDTS    TRCIN
                    - Used but not changed in the following subprograms:
                      TRC
PENERG              /BUTPAR/        R*4     BUTPAR.INC
                    Normalized energy of filter.
                    - Used but not changed in the following subprograms:
                      A50FCC  BUTFIL  BWJAM   FUNBW
PFACT(3)            /ERAD/          R*4     ERAD.INC
                    Cumulative probability distribution for effective
                    earth radius factor.
                            For NRAD = 1    PFACT = 0.89
                                     = 2          = 0.1
                                     = 3          = 0.01
                    - Used but not changed in the following subprograms:
                      PROUT
PHDIV               /MCOM4/         R*4     MCOM.INC
                    Squint angle between upper and lower receiver beams in
                    radians.  Default is beamwidth.
                    - Possibly given a new value in the following subprograms:
                      ANTGEO  INDATA  UNITCV
                    - Used but not changed in the following subprograms:
                      DIFSNR  LTCORR  OUTDAT
PHI                 /PATHGE/        R*4     TROCOM.INC
                    Diffraction angle in radians.
                    - Possibly given a new value in the following subprograms:
                      INTLIM  TRANSF  UNITCV
PHIR                /PATHGE/        R*4     TROCOM.INC
                    Receive angular distance to minimum scattering point
                    in radians.
                    - Possibly given a new value in the following subprograms:
                      TRANSF  UNITCV
PHIT                /PATHGE/        R*4     TROCOM.INC
                    Transmit angular distance to minimum scattering point
                    in radians.
                    - Possibly given a new value in the following subprograms:
                      TRANSF  UNITCV
PI                  /CONSTA/        R*4     CONSTANTS.INC
                    Constant Pi = 3.141592654.
                    - Used but not changed in the following subprograms:
                      ANTGEO  BUTFIL  DIF1    FFT     GPATT   JAMCOM  MDIF    PSPEC
                      PSPJ    SEARCH  SINC    SPEC    TPSPEC  TPSPJ   VARPOL
PJ                  /JAMPAR/        R*4     JAMPAR.INC
```

```
                 Normalization constant for interference calculations.
                 - Possibly given a new value in the following subprograms:
                   BWJAM
                 - Used but not changed in the following subprograms:
                   BUTFIL  FUNJAM
PLOSS1           /ERAD/          R*4     ERAD.INC
                 Reference troposcatter path loss in dB on lower beam
                 for NRAD equals 1.
                 - Possibly given a new value in the following subprograms:
                   POWER
PLOSSM           /PDATA/         R*4     PDATA.INC
                 Troposcatter path loss from approximate analytic
                 expression.
                 - Possibly given a new value in the following subprograms:
                   LOOPS
                 - Used but not changed in the following subprograms:
                   SUMPAG
POUT(20,20,3)    /ANSWER/        R*4     ANSWER.INC
                 AN/TRC-170 outage probability and average bit error
                 rate as a function of sampling time, short-term
                 average SNR and error rate threshold.
                 - Possibly given a new value in the following subprograms:
                   TRC
PRAD(3)          /ERAD/          R*4     ERAD.INC
                 Fraction of time effective earth radius factor is
                 greater than ERFAC; Probability that effective earth
                 radius factor is not exceeded.
                         For NRAD = 1    PRAD = 0.5
                                  = 2         = 0.1
                                  = 3         = 0.01
                 - Used but not changed in the following subprograms:
                   POWER
PSIRA0(NRMX)     /ANTENN/        R*4     TROCOM.INC
                 Array of receiver beam azimuths in radians.
                 - Possibly given a new value in the following subprograms:
                   ANTGEO  INDATA  UNITCV
                 - Used but not changed in the following subprograms:
                   CHKDAT  INTLIM  LOOPS   OUTDAT  SUMPAG  TRLOSS
PSIRE0(NRMX)     /ANTENN/        R*4     TROCOM.INC
                 Array of receiver beam boresight elevations above
                 radio horizon in radians, ie, angle at which each
                 antenna is aimed relative to the horizon.  PSIRE0(1)
                 is the main receive antenna.
                 - Possibly given a new value in the following subprograms:
                   ANTGEO  INDATA  TRANSF  UNITCV
                 - Used but not changed in the following subprograms:
                   CHKDAT  DIFSNR  INTLIM  JAMCOM  LOOPS   OUTDAT  POWER   SUMPAG
                   TRLOSS
PSITA0(NTMX)     /ANTENN/        R*4     TROCOM.INC
                 Array of transmitter beam azimuths in radians.
```

```
                 - Possibly given a new value in the following subprograms:
                   ANTGEO  INDATA  UNITCV
                 - Used but not changed in the following subprograms:
                   CHKDAT  INTLIM  LOOPS   OUTDAT  SUMPAG
PSITEO(NTMX)     /ANTENN/        R*4     TROCOM.INC
                 Array of transmitter beam boresight elevations above
                 radio horizon in radians, ie, angle at which each
                 antenna is aimed relative to the horizon.  PSITEO(1)
                 is the main transmit antenna.
                 - Possibly given a new value in the following subprograms:
                   ANTGEO  INDATA  TRANSF  UNITCV
                 - Used but not changed in the following subprograms:
                   CHKDAT  DIFSNR  INTLIM  LOOPS   OUTDAT  POWER   SUMPAG  TRLOSS
PULSE            /RZ/            I*2     RZ.INC
                 Switch controlling MD-918 pulse shape after
                 transmitter-receiver filtering.
                         PULSE = 0   Triangle
                               = 1   OQPSK matched filter
                               = 2   Sinc pulse, bandwidth equal to 1
                               = 5   RF filtering included
                 Set to 0 if IBW = 0 or KGAIN > 1.
                 Set to 5 if IBW > 0 and KGAIN = 1.
                 - Possibly given a new value in the following subprograms:
                   INDATA  SIGIN
                 - Used but not changed in the following subprograms:
                   CAC     CAJI    DINT    SINT
PXMIT            /MCOM4/         R*4     MCOM.INC
                 Rated transmission power in dBm.  Default is 70dBm.
                 - Possibly given a new value in the following subprograms:
                   INDATA
                 - Used but not changed in the following subprograms:
                   DIFSNR  OUTDAT  POWER
Q(NDELMX,NCORMX) /PDATA/         R*4     PDATA.INC
                 Matrix of troposcatter signal power and correlation
                 per unit delay profiles.
                 For DIVTYP = 0:
                    Q(.,1)  Power on lower beam vs. delay.
                    Q(.,2)  Correlation between lower and
                            upper beam vs. delay.
                    Q(.,3)  Correlation between lower beams
                            in antennas 1 & 2 vs. delay.
                    Q(.,4)  Power on upper beam vs. delay.
                    Q(.,7)  Power on diffraction path vs. delay
                 For DIVTYP = 1:
                    Q(.,1)  Power on lower beam vs. delay.
                    Q(.,2)  Correlation between lower and
                            upper beam vs. delay.
                    Q(.,3)  Power on upper beam vs. delay
                    Q(.,7)  Power on diffraction path vs. delay.
                 For DIVTYP = 2:
```

```
                    Q(.,1)  Power on path 1 (lower beam) vs. delay.
                    Q(.,2)  Correlation between convergent paths
                            (lower beam) vs. delay.
                    Q(.,3)  Correlation between divergent paths
                            (lower beam) vs. delay.
                    Q(.,4)  Correlation between parallel paths
                            (lower beam) vs. delay.
                    Q(.,5)  Correlation between crossing paths
                            (lower beam) vs. delay.
                    Q(.,6)  Power on path of upper beam vs. delay.
                    Q(.,7)  Power on diffraction path vs. delay.
                 - Possibly given a new value in the following subprograms:
                   LOOPS   MDIF    POWER
                 - Used but not changed in the following subprograms:
                   MAIN    SIM     SUMPAG
QCORR(NCORMX)    /PDATA/          R*4     PDATA.INC
                 Contains elements of covariance matrix, ie, powers and
                 correlations.
                 For DIVTYP = 0:
                    QCORR(1) Power on lower beam
                    QCORR(2) Correlation coefficient between lower
                             and upper beam.
                    QCORR(3) Correlation coefficient between lower
                             beams of antennas 1 and 2
                    QCORR(4) Power on upper beam.
                 For DIVTYP = 1:
                    QCORR(1) Power on lower beam
                    QCORR(2) Correlation coefficient between lower
                             and upper beam.
                    QCORR(3) Power on upper beam.
                 For DIVTYP = 2:
                    QCORR(1) Power on path 1 (lower beam)
                    QCORR(2) Correlation coefficient between convergent
                             paths.
                    QCORR(3) Correlation coefficient between divergent
                             paths.
                    QCORR(4) Correlation coefficient between parallel
                             paths.
                    QCORR(5) Correlation coefficient between crossing
                             paths.
                    QCORR(6) Power on upper beam.
                 - Possibly given a new value in the following subprograms:
                   LOOPS
                 - Used but not changed in the following subprograms:
                   POWER   SUMPAG
RCOR(32)         /RZ4/            R*4     RZ4.INC
                 Correlation function of the receive filter in steps
                 equal to the tapwidth (TAPW) for MD-918 modem, or
                 equal to 1/RATE for AN/TRC-170 or DAR modem.
                 - Used but not changed in the following subprograms:
```

```
                  BUTFIL  CAJI
RJCOR(129)      /RZ4/          R*4    RZ4.INC
                Correlation function of interferer-receiver filters at
                RATE points per symbol interval.
                - Possibly given a new value in the following subprograms:
                  BUTFIL
RJCORD(129)     /RZ4/          R*4    RZ4.INC
                Not used anymore but retained to align commons.
                -- Not used --
RLL             /SYSTRN/       R*4    TROCOM.INC
                Receiver line losses in dB.  Default is 0 dB.
                - Possibly given a new value in the following subprograms:
                  INDATA
                - Used but not changed in the following subprograms:
                  DIFSNR  OUTDAT  POWER   SUMPAG
RSDB            /BUTPAR/       R*4    BUTPAR.INC
                10 times the base 10 logarithm of the symbol rate
                minus 60.
                - Possibly given a new value in the following subprograms:
                  BUTFIL
                - Used but not changed in the following subprograms:
                  A50FCC  FCCMSK
RSEP(3)         /IODATA/       R*4    IODATA.INC
                Separation between receive antennas.
                - Possibly given a new value in the following subprograms:
                  ANTGEO  INDATA
RSNMIN(3)       /NUMPAR/       R*4    NUMPAR.INC
                SNR threshold corresponding to each bit error rate
                threshold for AN/TRC-170.
                - Used but not changed in the following subprograms:
                  POUTAG
RSNRSN(30)      /NUMPAR/       R*4    NUMPAR.INC
                Set of SNR values for which solution of transcendental
                function (UPISIM) is tabulated.
                - Used but not changed in the following subprograms:
                  POUTAG
S               /PATHGE/       R*4    TROCOM.INC
                Troposcatter path asymmetry parameter.
                - Possibly given a new value in the following subprograms:
                  TRANSF
                - Used but not changed in the following subprograms:
                  SUMPAG
S1              /PATHGE/       R*4    TROCOM.INC
                Troposcatter path asymmetry parameter.
                - Possibly given a new value in the following subprograms:
                  TRANSF
SCPARM          /PROPAR/       R*4    TROCOM.INC
                Wavenumber spectrum slope parameter M.  Default is
                3.66.
                - Possibly given a new value in the following subprograms:
```

```
                         INDATA
                       - Used but not chansed in the followins subprosrams:
                         INTLIM  LOOPS   OUTDAT  STPPAR  SUMPAG  TRLOSS
     SEAN              /PROPAR/        R*4     TROCOM.INC
                       Minimum monthly median of refractivity at sea level.
                       Used to calculate ERFAC if non-zero.
                       - Possibly siven a new value in the followins subprosrams:
                         INDATA  MAIN
                       - Used but not chansed in the followins subprosrams:
                         AVAIL   OUTDAT
     SIGMA             /SYSPAR/        R*4     SYSPAR.INC
                       Half the RMS lower beam delay spread normalized
                       relative to the symbol duration.
                       - Possibly siven a new value in the followins subprosrams:
                         TRCIN
                       - Used but not chansed in the followins subprosrams:
                         EIGV    TIMPAR  TRC     VARW
     SMI               /UNIT/          R*4     IODATA.INC
                       Strins 'smi ' for units output.
                       - Used but not chansed in the followins subprosrams:
                         OUTDAT  UNITS
     SNDB(2)           /IOUT/          R*4     IOUT.INC
                       Sisnal to noise ratio in dB.
                       - Possibly siven a new value in the followins subprosrams:
                         TRCIN
                       - Used but not chansed in the followins subprosrams:
                         TRC
     SNR               /SYSPAR/        R*4     SYSPAR.INC
                       Sisnal to noise ratio.
                       - Possibly siven a new value in the followins subprosrams:
                         TRC     TRCIN
                       - Used but not chansed in the followins subprosrams:
                         PAVERG  POUTAG
     SNRBW             /RZ4/           R*4     RZ4.INC
                       Sisnal to noise ratio adjustment for AN/TRC-170 due to
                       limited receive filter bandwidth.
                       - Possibly siven a new value in the followins subprosrams:
                         BUTFIL
                       - Used but not chansed in the followins subprosrams:
                         TRC
     SNRF2             /RZ4/           R*4     RZ4.INC
                       Parameter to adjust the sisnal to noise ratio for
                       desradation due to interference from another
                       freauency.  Only for 2-freauency AN/TRC-170 modem.
                       - Possibly siven a new value in the followins subprosrams:
                         BUTFIL
                       - Used but not chansed in the followins subprosrams:
                         TRC
     SNRJAM            /RZ4/           R*4     RZ4.INC
                       Parameter to adjust the sisnal to noise ratio of
```

```
                  AN/TRC-170 for degradation due to colocated/adjacent
                  channel interference.
                  - Possibly given a new value in the following subprograms:
                    BUTFIL
                  - Used but not changed in the following subprograms:
                    TRC
SP                /MCOM4/         R*4     MCOM.INC
                  Service probability.  Default is .95.
                  - Possibly given a new value in the following subprograms:
                    INDATA
                  - Used but not changed in the following subprograms:
                    DIFSNR  OUTDAT  POWER
SPE               /PDATA/         R*4     PDATA.INC
                  Tap spacing in nanoseconds.  Default is 67 nsec.
                  - Possibly given a new value in the following subprograms:
                    INDATA
                  - Used but not changed in the following subprograms:
                    SIM
SPREAD(NCORMX)    /PDATA/         R*4     PDATA.INC
                  Array of delay spreads (2-sigma) for each beam in
                  seconds.
                  - Used but not changed in the following subprograms:
                    POWER   SUMPAG
STSNR             /SUMP/          R*4     SUMP.INC
                  Standard deviation of troposcatter signal long-term
                  SNR distribution in dB.
                  - Possibly given a new value in the following subprograms:
                    POWER
                  - Used but not changed in the following subprograms:
                    MAIN    MDTS    SUMPAG
STSNR1            /SYSPAR/        R*4     SYSPAR.INC
                  Standard deviation of troposcatter signal long-term
                  SNR distribution in dB.  Same as STSNR in /SUMP/.
                  - Possibly given a new value in the following subprograms:
                    TRCIN
                  - Used but not changed in the following subprograms:
                    TRC
SUPRES            /IODATA/        L*4     IODATA.INC
                  Supress long output in SUMPAG if true.
                  Set to TRUE if PTYPE > 9.
                  - Possibly given a new value in the following subprograms:
                    INDATA
                  - Used but not changed in the following subprograms:
                    SUMPAG
TO                /SYSPAR/        R*4     SYSPAR.INC
                  Normalized sampling time for lower beam.
                  - Possibly given a new value in the following subprograms:
                    TIMEQL  TRC
                  - Used but not changed in the following subprograms:
                    EIGV    TIMPAR  VARW
```

```
SASEQ  (Subroutine) outputs to FOR002.DAT the following variables:
       IASEQ   I*2    LOC    PN chip sequence.

SIM    (Subroutine) outputs to FOR002.DAT the following variables:
       I       I*2    LOC    Beam number.
       IC1     I*2    LOC    Beam pointer of tap correlation calculation.
       IC2     I*2    LOC    Beam pointer of tap correlation calculation.
       IQ1     I*2    LOC    Beam pointer of tap gain calculation.
       IQ2     I*2    LOC    Beam pointer of tap gain calculation.
       ISPE    I*2    LOC    Tap spacing in nanoseconds.
       I1CORR  I*2    GLO    Array of receiving beams involved in the
                             correlation calculations.
       I2CORR  I*2    GLO    Array of receiving beams involved in the
                             correlation calculations.
       PCF     R*4    LOC    Power correction factor in dB.
       SNEG    R*4    LOC    Attenuation in dB.
       TEMP1   R*4    LOC    Correlation coefficient.

SINT   (Subroutine) outputs to FOR002.DAT the following variables:
       DU      R*8    GLO    Signal response after PN sequence correlation.

SUBID  (Subroutine) outputs to FOR002.DAT the following variables:
       SNAME   R*8    ARG    Name of the subprogram that called SUBID.

SUMPAG (Subroutine) outputs to SUMPAG.OUT the following variables:
       AA      R*4    GLO    Atmospheric absorption loss in dB.
       ALFA0   R*4    GLO    Minimum elevation angle measured from
                             transmitter-to-receiver line to transmit
                             horizon line in radians.
       AR      R*4    GLO    Array of receiver antenna diameters in meters.
                             AR(1)is equivalent to RDIAM in the input file.
       AT      R*4    GLO    Array of transmit antenna diameters in meters.
                             AT(1)is equivalent to TDIAM in the input file.
       BER     R*4    GLO    Bit error rate thresholds of interest.  Set
                             to 1E-3, 1E-4 and 1E-5 in data statement.
       BETA0   R*4    GLO    Minimum elevation angle measured from
                             receiver-to-transmitter line to receiver
                             horizon line in radians.
       BOUT    R*4    ARG    Yearly average fade outage probability for each
                             bit error rate threshold specified and 2S/2F
                             and 2S diversity configurations.
       CLIMAT  R*4    ARG    Climate zone indicator.
       D       R*4    GLO    Great circle distance between transmitter
                             and receiver measured at sea level in meters.
       DE      R*4    GLO    Effective distance for troposcatter path in
                             kilometers.
       DIFLOS  R*4    GLO    Median diffraction path loss in dB for each
                             value in ERFAC distribution.
       DIFRSL  R*4    GLO    Median diffraction signal RSL in dBm for each
                             value in ERFAC distribution.
```

			upper beam.
RSL	R*4	LOC	Received signal level distribution of scatter component.
SNR	R*4	LOC	SNR per bit distribution of scatter component in dB.
SP	R*4	GLO	Service probability. Default is .95.
STSNR	R*4	GLO	Standard deviation of troposcatter signal long-term SNR distribution in dB.
TAU22	R*8	ARG	Delay spread on lower beam in nsec.
TAU23	R*8	ARG	Delay spread on upper beam in nsec.
TEMP1	R*4	LOC	Reference pathloss of scatter component on lower beam.
TEMP2	R*4	LOC	Reference pathloss of scatter component on upper beam.
THER	R*4	GLO	Radio horizon elevation angle at receive site in radians.
THET	R*4	GLO	Radio horizon elevation angle at transmit site in radians.
TLOSS	R*4	LOC	Pathloss distribution of scatter component in dB.
VDE	R*4	ARG	Time variability of basic transmission loss in dB.
YO	R*4	LOC	Variability in the RSL and the path loss about the median.

PROUT (Subroutine) outputs to FOR002.DAT the following variables:

ABE	R*4	ARG	Average 1000-bit block error probability for each configuration.
ABEL	R*4	GLO	Cumulative block error probability for each diversity configuration as specified by DIVTYP (averaged over multipath distribution, if any).
BER	R*4	GLO	Bit error rate thresholds of interest. Set to 1E-3, 1E-4 and 1E-5 in data statement.
BOUT	R*4	ARG	Outage probability for each BER threshold and diversity configuration.
BOUTL	R*4	GLO	Cumulative outage probability for each diversity configuration and error rate threshold (averaged over multipath distribution, if any).
FOUT	R*4	ARG	Fade outage per call minute for each BER threshold and diversity configuration:
FOUTL	R*4	GLO	Cumulative fade outage per call minute for each diversity configuration and error rate threshold (averaged over multipath distribution, if any).
NOUT	I*2	ARG	Total number of short term calculations performed.
P	R*4	LOC	Same as BER above.

OUTDAT (Subroutine) outputs to FOR002.DAT the following variables:
(This output is merely a summary of the input variables which are fully described in section 3.2 of the User's Manual.)

POWER (Subroutine) outputs to FOR002.DAT the following variables:

AA	R*4	GLO	Atmospheric absorption loss in dB.
ASNR	R*4	ARG	Median and/or yearly average value of troposcatter signal SNR in dB.
AVERX	R*4	GLO	Average terrain elevation above sea level between receive site and radio horizon, in meters.
AVETX	R*4	GLO	Average terrain elevation above sea level between transmit site and radio horizon, in meters.
BWR	R*4	ARG	Transmit antenna beamwidth in degrees.
BWT	R*4	ARG	Receive antenna beamwidth in degrees.
CORRLT	R*4	GLO	Correlation coefficient for long term variability of lower and upper beams.
CPL	R*4	GLO	Correlation coefficient for long term variability of lower and upper beams.
DE	R*4	GLO	Effective distance for troposcatter path in kilometers.
DEL1	R*4	LOC	Relative average delay of lower beam in nanoseconds.
DEL2	R*4	LOC	Relative average delay of upper beam in nanoseconds.
DSP1	R*4	GLO	Lower beam troposcatter signal RMS delay spread in nanoseconds for percentiles 50, 90 and 99.
DSP2	R*4	GLO	Upper beam troposcatter signal RMS delay spread in nanoseconds for percentiles 50, 90 and 99.
ERFAC	R*4	GLO	Yearly median value of effective earth radius factor k in kilometers. Default is 1.33.
HRE	R*4	GLO	Effective receiver antenna height above average terrain elevation in meters.
HTE	R*4	GLO	Effective transmitter antenna height above average terrain elevation in meters.
IBLOSS	I*2	GLO	Beam number corresponding to CPL(I).
ITER	I*2	GLO	Number of integration cells in the common volume integration.
PMED	R*4	LOC	Short term median pathloss.
PRAD	R*4	GLO	Fraction of time effective earth radius factor is greater than ERFAC; Probability that effective earth radius factor is not exceeded. For NRAD = 1 PRAD = 0.5 = 2 = 0.1 = 3 = 0.01
RH1	R*8	ARG	Correlation coeffiecient between lower and

MATCO (Subroutine) outputs to FOR002.DAT the following variables:

A	R*4	ARG	Noise matrix for AFE taps.
C	R*4	ARG	Covariance matrix for AFE taps.
CSUM	R*4	ARG	ISI matrix for AFE taps.

MDIF (Subroutine) outputs to FOR002.DAT the following variables:

AV1	R*4	LOC	Diffraction loss in dB.
AV2	R*4	LOC	Diffraction loss in dB.
DELE9	R*4	LOC	Diffraction path relative delay in nsec.
D1E3	R*4	LOC	Reference delay in msec.
K	I*2	LOC	Edge number.
LB	R*4	ARG	Long term reference basic path loss in dB.
LDIF	R*4	LOC	Diffraction loss in dB.
LF	R*4	LOC	Free-space loss in dB.
PHI	R*4	LOC	Diffraction angle.
RC	R*4	LOC	Radius of curvature in meters.

MDTS (Subroutine) outputs to FOR002.DAT the following variables:

ASEP	R*4	ARG	Receiver antenna separation in meters.
ASEQ	I*2	LOC	PN chip sequence.
CGAIN	R*4	LOC	Coding gain at specified error rate threshold.
CRATE	R*4	LOC	Code rate.
DBLOSS	R*8	LOC	Attenuation of interference due to sidelobes of receiving antenna.
DEL	R*4	GLO	Diffraction path delay relative to a straight line path in seconds.
DEX	R*8	LOC	Determinant of SNR matrix.
DGRMOD	R*4	LOC	Modem degradation in dB.
DSNR	R*4	LOC	Diffraction component SNR in dB.
FSIG	R*4	LOC	Mean tap amplitudes.
JANG	R*8	LOC	Interference angle of incidence.
JBWX	R*8	LOC	Interfering signal bandwidth.
KGAIN	I*2	GLO	Integer ratio of bandwidth to data rate.
PEAKAV	R*4	GLO	Peak-to-average loss due to RF filtering in dB.
SNR	R*4	LOC	Scatter component SNR in dB.
TDIFF	R*4	GLO	Normalized relative delay between lower and upper beam.
TEMPA	R*4	ARG	Average relative delay of scatter component.
TSCAT	R*4	LOC	Normalized relative delay of scatter component.
TZ	R*4	LOC	Interferer normalized delay difference on two antennas.
T0	R*4	LOC	Normalized sampling time for AFE center tap.
U	R*8	LOC	Implicit diversity eigenvalues.
XDIFR	R*4	LOC	Fraction of received power due to diffraction component.
XSCAT	R*4	LOC	Fraction of received power due to scatter component.
Z	R*4	LOC	Transformed mean tap values.

			1 = (not allowed)
			2 = AN/TRC-170 receiver filter. Also means filter is a Butterworth.
IFILTX	I*2	GLO	Transmitter filter indicator.
			0 = MD-918 transmitter filter. Also means filter is a Butterworth cascaded with a rectangular impulse response filter of duration equal to symbol duration.
			1 = AN/TRC-170 transmitter filter. Also means filter is a cascade of Butterworth filter with rectangular impulse response filter of duration equal to half symbol duration.
			2 = (not allowed)
NPOLRX	I*2	GLO	Number of poles in the receive Butterworth filter.
NPOLTX	I*2	GLO	Number of poles in the transmit Butterworth filter.
PEAKAV	R*4	GLO	Peak-to-average loss due to RF filtering in dB.
TEMP1	R*4	LOC	99% bandwidth in MHz.

CLIFIT (Subroutine) outputs to FOR002.DAT the following variables:

ALFA	R*4	LOC	Constant in user defined 90% variability curve.
BETA	R*4	LOC	Constant in user defined 90% variability curve.
CF	R*4	LOC	Constant in user defined 90% variability curve.
C0	R*4	LOC	Constant in user defined 90% variability curve.
C1	R*4	LOC	Constant in user defined 90% variability curve.
C2	R*4	LOC	Constant in user defined 90% variability curve.

DIFSNR (Subroutine) outputs to FOR002.DAT the following variables:

ASNR	R*4	ARG	Median and/or yearly average value of diffraction path SNR in dB.
DLOSS	R*4	LOC	Diffraction pathloss distribution.
DSTSNR	R*4	GLO	Standard deviation of diffracted signal long-term SNR distribution in dB.
DUPOWL	R*4	LOC	Ratio of diffraction signal on upper beam to that on lower beam in dB.
QT	R*4	LOC	Percentile not exceeded.
RSL	R*4	LOC	Received signal level distribution of diffraction component in dBm.
SNR	R*4	LOC	SNR per bit distribution of diffraction component in dB.
SP	R*4	GLO	Service probability. Default is .95.

ERRIO (Subroutine) outputs to FOR002.DAT the following variables:

I	I*2	ARG	Error number. This is followed by the corresponding error message.

ERROR (Subroutine) outputs to FOR002.DAT the following variables:

I	I*2	ARG	Error number. This is followed by the corresponding error message.

UTPUT VARIABLES

D.1 Output Variable Definitions

AVAIL (Subroutine) outputs to FOR002.DAT the following variables:

I	I*2	LOC	Section of diffraction path with Fresnel zone blockage.
PLOSS	R*4	LOC	Pathloss distribution of diffraction component.
QT	R*4	ARG	Array containing percent of time pathloss is not exceeded, i.e. time availability.
SIG	R*4	LOC	Standard deviation of predicted pathloss.
V1	R*4	LOC	Variability distribution about reference pathloss for diffraction component.
Y	R*4	ARG	Array containing pathloss variability distribution about the median in dB.

BERCAL (Subroutine) outputs to FOR002.DAT the following variables:

BERAV	R*4	LOC	Short term average bit error rate.
DSNR	R*4	ARG	Specular component SNR in dB.
FCMIN	R*4	LOC	Fade outage per call minute.
ID	I*2	LOC	Explicit diversities on the main beam.
ITOT	I*2	LOC	Total number of explicity diversities.
JPOW	R*8	ARG	Interferer power density in dBm/Hz.
JSR	R*8	ARG	Interferer to signal power ratio in dB.
P	R*8	LOC	Error rate outage threshold.
PFO	R*8	LOC	Probability that bit error rate exceeds threshold; short term outage probability.
SNR	R*4	ARG	Mean hourly SNR in dB at which outage probability is to be calculated.
SUM2	R*4	LOC	2 times average bit error probability if only one independent diversity. Otherwise 1000-bit block error probability.
XTYPE	R*8	LOC	Outputs the string identifying the diversity type.

BOTAC (Subroutine) outputs to FOR002.DAT the following variables:

K1	I*2	ARG	Number of taps in forward equalizer.
TAC	R*4	ARG	Interferer covariance matrix calculated according to RF filtering specified through IBW and JFILT parameters.
TAPW	R*4	GLO	Normalized tapwidth for MD-918. Default is .5. Range is 0.25 through 1.0

BUTFIL (Subroutine) outputs to FOR002.DAT the following variables:

FCUT	R*4	LOC	Transmission bandwidth in MHz.
FCUT1	R*4	LOC	Cut-off frequency for the transmitter.
FCUT2	R*4	LOC	Cut-off frequency for the receiver.
IFILRX	I*2	GLO	Receiver filter indicator. 0 = MD-918 receiver filter. Also means filter is a Butterworth cascaded with a rectangular impulse response filter of duration equal to symbol duration.

APPENDIX D

OUTPUT VARIABLES

This appendix describes all variables written to the output files, FOR002.DAT and SUMPAG.OUT. In the following descriptions each variable is identified by type and where it came from, ie, LOC for local, GLO for global, ARG for arguments.

The type, for variables is given as three characters:

L*1	1 byte LOGICAL (BYTE in the PDP version)
L*4	4 byte LOGICAL
I*2	2 byte INTEGER
I*4	4 byte INTEGER
R*4	4 byte REAL
R*8	8 byte REAL
C*8	8 byte COMPLEX

```
                         CAC     TXPULS
      Y1                /PATHGE/        R*4     TROCOM.INC
                        Maximum estimated integration length in Y-direction.
                        - Possibly given a new value in the following subprograms:
                          INTLIM  UNITCV
                        - Used but not changed in the following subprograms:
                          LOOPS
      Y900              /CURVE/         R*4     CURVE.INC
                        User supplied value for 90th percentile variability
                        curve Y0(90) for DE greater than or equal 900 km.
                        Used only when ICLIME is 2.  Used to compute the
                        equation for the Y0(90) curve fit.
                        - Possibly given a new value in the following subprograms:
                          CLIMIL  INDATA
                        - Used but not changed in the following subprograms:
                          CLIFIT  OUTDAT
      YMIN              /CURVE/         R*4     CURVE.INC
                        User supplied value for 90th percentile variability
                        curve Y0(90) for DE equal to DEMIN.  Used only when
                        ICLIME is 2.  Used to compute the equation for the
                        Y0(90) curve fit.
                        - Possibly given a new value in the following subprograms:
                          CLIMIL  INDATA
                        - Used but not changed in the following subprograms:
                          CLIFIT  OUTDAT
      YZERO             /CURVE/         R*4     CURVE.INC
                        User supplied value for 90th percentile variability
                        curve Y0(90) for DE equal to 0.  Used only when ICLIME
                        is 2.
                        - Possibly given a new value in the following subprograms:
                          CLIMIL  INDATA
                        - Used but not changed in the following subprograms:
                          CLIFIT  OUTDAT
```

```
                PSPJ    TPSPJ
WLT             /SYSTRN/        R*4     TROCOM.INC
                Rated transmission power in Watts.  Default is 1000 W.
                - Possibly given a new value in the following subprograms:
                  INDATA
                - Used but not changed in the following subprograms:
                  OUTDAT  SUMPAG
X2INCR          /NUMPAR/        R*4     NUMPAR.INC
                Step increment for numerical integration.
                - Possibly given a new value in the following subprograms:
                  TRC
X3INCR          /NUMPAR/        R*4     NUMPAR.INC
                Step increment for numerical integration.
                - Used but not changed in the following subprograms:
                  AVG
XANG(10)        /MCOM4/         R*4     MCOM.INC
                Interferer azimuth angles in degrees.  Default is 0.
                - Possibly given a new value in the following subprograms:
                  INDATA
                - Used but not changed in the following subprograms:
                  MDTS    OUTDAT
XAVAR           /ANSWER/        R*4     ANSWER.INC
                Standard deviation of past ISI for AN/TRC-170.
                - Possibly given a new value in the following subprograms:
                  TRC
                - Used but not changed in the following subprograms:
                  POUTAG
XBVAR           /ANSWER/        R*4     ANSWER.INC
                Standard deviation of future ISI for AN/TRC-170.
                - Possibly given a new value in the following subprograms:
                  TRC
                - Used but not changed in the following subprograms:
                  POUTAG
XINCR           /NUMPAR/        R*4     NUMPAR.INC
                Step increment for numerical integration.
                - Possibly given a new value in the following subprograms:
                  TRC
XTRO            /RZ4/           R*4     RZ4.INC
                Time origin for transmit-receive filter impulse
                response (TRFILT), ie, X is TRFILT(X+XTRO).
                - Possibly given a new value in the following subprograms:
                  BUTFIL
                - Used but not changed in the following subprograms:
                  CAC     TXPULS
XTRINC          /RZ4/           R*4     RZ4.INC
                Sample interval for calculation of transmit-receive
                filter impulse response (TRFILT).
                - Possibly given a new value in the following subprograms:
                  BUTFIL
                - Used but not changed in the following subprograms:
```

```
                    Array of transmit antennas horizontal offsets in
                    meters.
                    - Possibly given a new value in the following subprograms:
                      ANTGEO  INDATA  UNITCV
                    - Used but not changed in the following subprograms:
                      CHKDAT  LOOPS   OUTDAT  STPPAR  SUMPAG
UTL(NT)             /PATHGE/        R*4     TROCOM.INC
                    Array of transmit antennas longitudinal offsets in
                    meters.
                    - Possibly given a new value in the following subprograms:
                      ANTGEO  INDATA  UNITCV
                    - Used but not changed in the following subprograms:
                      CHKDAT  LOOPS   OUTDAT  SUMPAG
UTV(NT)             /PATHGE/        R*4     TROCOM.INC
                    Array of transmit antennas vertical offsets in meters.
                    - Possibly given a new value in the following subprograms:
                      ANTGEO  INDATA  UNITCV
                    - Used but not changed in the following subprograms:
                      CHKDAT  LOOPS   OUTDAT  SUMPAG
VARAIS              /ANSWER/        R*4     ANSWER.INC
                    Past ISI variance for AN/TRC-170.
                    - Possibly given a new value in the following subprograms:
                      TRC
VARBIS              /ANSWER/        R*4     ANSWER.INC
                    Future ISI variance for AN/TRC-170.
                    - Possibly given a new value in the following subprograms:
                      TRC
VARISI              /ANSWER/        R*4     ANSWER.INC
                    Total ISI variance for AN/TRC-170.
                    - Possibly given a new value in the following subprograms:
                      TRC
                    - Used but not changed in the following subprograms:
                      PAVERG
VEIGV(20)           /ANSWER/        R*8     ANSWER.INC
                    Implicit diversity eigenvalues for AN/TRC-170.
                    - Possibly given a new value in the following subprograms:
                      EIGV    TRC
                    - Used but not changed in the following subprograms:
                      AVG
WAVLEN              /SYSTRN/        R*4     TROCOM.INC
                    Wavelength in meters.
                    - Possibly given a new value in the following subprograms:
                      INDATA
                    - Used but not changed in the following subprograms:
                      ANTPAR  LOOPS   RGAIN   STPPAR  TGAIN
WFM                 /JAMPAR/        R*4     JAMPAR.INC
                    Normalization constant for FDM/FM interference.
                    - Possibly given a new value in the following subprograms:
                      BWJAM
                    - Used but not changed in the following subprograms:
```

```
                   Units of angle (deg, mrad).
                   - Possibly given a new value in the following subprograms:
                     UNITS
                   - Used but not changed in the following subprograms:
                     ANTGEO  OUTDAT  SUMPAG
UDIST              /UNIT/          R*4     IODATA.INC
                   Units of distance (smi, nmi, km).
                   - Possibly given a new value in the following subprograms:
                     UNITS
                   - Used but not changed in the following subprograms:
                     INDATA  OUTDAT  SUMPAG
UFREQ              /UNIT/          R*4     IODATA.INC
                   Units of frequency (GHz, MHz).
                   - Possibly given a new value in the following subprograms:
                     UNITS
                   - Used but not changed in the following subprograms:
                     ANTGEO  INDATA  OUTDAT  SUMPAG
UHITE              /UNIT/          R*4     IODATA.INC
                   Units of height and diameter (ft, m).
                   - Possibly given a new value in the following subprograms:
                     UNITS
                   - Used but not changed in the following subprograms:
                     ANTGEO  OUTDAT  SUMPAG
UPISIM(30,3)       /NUMPAR/        R*4     NUMPAR.INC
                   Solution of transcendental equation for each value of
                   RSNRSN and bit error rate threshold of interest in
                   AN/TRC-170 outage probability calculation.
                   - Used but not changed in the following subprograms:
                     POUTAG
URH(NR)            /PATHGE/        R*4     TROCOM.INC
                   Array of receive antennas horizontal offsets from
                   great circle plane in meters.
                   - Possibly given a new value in the following subprograms:
                     ANTGEO  INDATA  UNITCV
                   - Used but not changed in the following subprograms:
                     CHKDAT  LOOPS   OUTDAT  STPPAR  SUMPAG
URL(NR)            /PATHGE/        R*4     TROCOM.INC
                   Array of receive antennas longitudinal offsets in
                   meters.
                   - Possibly given a new value in the following subprograms:
                     ANTGEO  INDATA  UNITCV
                   - Used but not changed in the following subprograms:
                     CHKDAT  LOOPS   OUTDAT  SUMPAG
URV(NR)            /PATHGE/        R*4     TROCOM.INC
                   Array of receive antennas vertical offsets in meters.
                   - Possibly given a new value in the following subprograms:
                     ANTGEO  INDATA  UNITCV
                   - Used but not changed in the following subprograms:
                     CHKDAT  LOOPS   OUTDAT  SUMPAG
UTH(NT)            /PATHGE/        R*4     TROCOM.INC
```

```
                  INTLIM  LOOPS   LTCORR  SUMPAG
THETRF          /PATHGE/         R*4     TROCOM.INC
                Transmit reference horizon elevation in radians.
                - Possibly given a new value in the following subprograms:
                  TRANSF
TLL             /SYSTRN/         R*4     TROCOM.INC
                Transmitter line losses in dB.  Default is 0 dB.
                - Possibly given a new value in the following subprograms:
                  INDATA
                - Used but not changed in the following subprograms:
                  DIFSNR  OUTDAT  POWER   SUMPAG
TODAY(9)        /TSTAMP/         L*1     IODATA.INC
                Array used in PDP-11 version to hold date as
                characters.
                - Used but not changed in the following subprograms:
                  MAIN    OUTDAT  SUMPAG
TPAR(20)        /ANSWER/         R*4     ANSWER.INC
                Timing parameter for AN/TRC-170.  Calculated when
                IOTIME is 0.
                - Possibly given a new value in the following subprograms:
                  TRC
TRFILT(128)     /RZ4/            R*4     RZ4.INC
                Transmit-receive filter impulse response.
                - Possibly given a new value in the following subprograms:
                  BUTFIL
                - Used but not changed in the following subprograms:
                  CAC     TXPULS
TROLOS(3)       /SUMP/           R*4     CURVE.INC
                Median troposcatter path loss in dB for each value in
                ERFAC distribution.
                - Possibly given a new value in the following subprograms:
                  POWER
                - Used but not changed in the following subprograms:
                  SUMPAG
TRORSL(3)       /SUMP/           R*4     CURVE.INC
                Median troposcatter RSL in dBm for each value in ERFAC
                distribution.
                - Possibly given a new value in the following subprograms:
                  POWER
                - Used but not changed in the following subprograms:
                  SUMPAG
TSEP(3)         /IODATA/         R*4     IODATA.INC
                Separation between transmit antennas in meters.
                - Possibly given a new value in the following subprograms:
                  ANTGEO  INDATA
TWOPI           /CONSTA/         R*4     CONSTANTS.INC
                2 X Pi = 6.283185307.
                - Used but not changed in the following subprograms:
                  LOOPS   RJCFCN  STPPAR
UANGLE          /UNIT/           R*4     IODATA.INC
```

```
                    STEPAB
TFAKY1            /STPCOM/       R*4     STPCOM.INC
                  Constant for common volume integrat.cn.
                  - Possibly given a new value in the following subprograms:
                    STPPAR
                  - Used but not changed in the following subprograms:
                    STEPY
TFAKY2            /STPCOM/       R*4     STPCOM.INC
                  Constant for common volume integration.
                  - Possibly given a new value in the following subprograms:
                    STPPAR
                  - Used but not changed in the following subprograms:
                    STEPY
TFAKY3            /STPCOM/       R*4     STPCOM.INC
                  Constant for common volume integration.
                  - Possibly given a new value in the following subprograms:
                    STPPAR
                  - Used but not changed in the following subprograms:
                    STEPY
TFAKY4            /STPCOM/       R*4     STPCOM.INC
                  Constant for common volume integration.
                  - Possibly given a new value in the following subprograms:
                    STPPAR
                  - Used but not changed in the following subprograms:
                    STEPY
THER              /PATHGE/       R*4     TROCOM.INC
                  Radio horizon elevation angle at receive site in
                  radians.
                  - Possibly given a new value in the following subprograms:
                    INDATA  UNITCV
                  - Used but not changed in the following subprograms:
                    DIFSNR  INTLIM  JAMCOM  LTCORR  MAIN    OUTDAT  POWER   SUMPAG
                    TRANSF
THERRF            /PATHGE/       R*4     TROCOM.INC
                  Receive reference horizon in radians.
                  - Possibly given a new value in the following subprograms:
                    TRANSF
THET              /PATHGE/       R*4     TROCOM.INC
                  Radio horizon elevation angle at transmit site in
                  radians.
                  - Possibly given a new value in the following subprograms:
                    INDATA  UNITCV
                  - Used but not changed in the following subprograms:
                    DIFSNR  INTLIM  LOOPS   MAIN    OUTDAT  POWER   SUMPAG  TRANSF
THETA0            /PATHGE/       R*4     TROCOM.INC
                  Scattering angle at bottom of common volume in
                  radians.
                  - Possibly given a new value in the following subprograms:
                    TRANSF  UNITCV
                  - Used but not changed in the following subprograms:
```

```
TOTO(20)        /IOUT/          R*4     IOUT.INC
                Array of sampling times (normalized to symbol
                duration) for calculation of short term AN/TRC-170
                performance.
                - Used but not changed in the following subprograms:
                  TRC
TAPOUT          /PDATA/         L*4     PDATA.INC
                If true, the simulator tap values are output to the
                output file, FOR002.DAT.  Default is TRUE.
                - Possibly given a new value in the following subprograms:
                  INDATA
                - Used but not changed in the following subprograms:
                  SUMPAG
TAPW            /MCOM4/         R*4     MCOM.INC
                Normalized tapwidth for MD-918.  Default is .5.
                Range is 0.25 through 1.0
                - Possibly given a new value in the following subprograms:
                  INDATA  SIGIN
                - Used but not changed in the following subprograms:
                  BOTAC   CAJI    CAKL    JAMCOM  MAIN    MATCO   OUTDAT
TDEV            /NUMPAR/        R*4     NUMPAR.INC
                Standard deviation of sampling times for AN/TRC-170
                performance calculations.
                - Used but not changed in the following subprograms:
                  TRC
TDIFF           /MCOM4/         R*4     MCOM.INC
                Normalized relative delay between lower and upper
                beam.
                - Possibly given a new value in the following subprograms:
                  MDTS    POWER
                - Used but not changed in the following subprograms:
                  DINT    MATCO
TEMPA(NCORMX)   /PDATA/         R*4     PDATA.INC
                Array of average troposcatter signal delays for each
                beam relative to straight line in seconds.
                - Possibly given a new value in the following subprograms:
                  LOOPS
                - Used but not changed in the following subprograms:
                  MAIN    POWER   SUMPAG
TERFAC(3)       /ERAD/          R*4     ERAD.INC
                The three values of ERFAC when MDIST is 1.
                - Possibly given a new value in the following subprograms:
                  INDATA
                - Used but not changed in the following subprograms:
                  MAIN
TFAK            /STPCOM/        R*4     STPCOM.INC
                Constant for common volume integration.
                - Possibly given a new value in the following subprograms:
                  STPPAR
                - Used but not changed in the following subprograms:
```

DIVTYP	I*2	GLO	Diversity configuration indicator. Default is 0.
DLR	R*4	GLO	Distance from receiver to radio horizon.
DLT	R*4	GLO	Distance from transmitter to radio horizon.
DSTSNR	R*4	GLO	Standard deviation of diffracted signal long-term SNR distribution in dB.
ERFAC	R*4	GLO	Yearly median value of effective earth radius factor k in kilometers. Default is 1.33.
ERR	R*4	GLO	Integration resolution. Default is .001.
F	R*4	GLO	Operating frequency in Hz.
FOUT	R*4	ARG	Yearly average fade outage probability per call minute for each bit error rate threshold specified and 2S/2F and 2S diversity configurations.
HCOM	R*4	GLO	Effective height of the bottom of the common volume.
HHIGH	R*4	GLO	Effective height of the top of the common volume.
HLR	R*4	GLO	Receiver radio horizon elevation above sea level.
HLT	R*4	GLO	Transmit radio horizon elevation above sea level.
ITER	I*2	GLO	Number of integration cells in the common volume integration.
JPOW	R*8	ARG	Interference signal power density in dBm/Hz.
LNAME	I*2	GLO	Link name. Transmitter site first, receiver site second. Used as link identifier on output files FOR002.DAT and SUMPAG.OUT.
LUNITS	I*2	GLO	Integer value that specifies the set of units requested by the user. These units are for path, antenna location, angle, and frequency parameters. Default is 8.
NACCU	I*2	GLO	Parameter used as truncation point for common volume integration termination. Default is 40.
NEWCL	I*2	GLO	New climate type character string.
NOW	L*1	GLO	Array used in PDP-11 version to hold time of day as characters.
NPAG	I*2	LOC	Page number.
NT	I*2	GLO	Number of transmit ports.
PSIREO	R*4	GLO	Array of receiver beam boresight elevations above radio horizon in radians, ie, angle at which each antenna is aimed relative to the horizon. PSIREO(1) is the main receive antenna.
PSITEO	R*4	GLO	Array of transmitter beam boresight elevations above radio horizon in radians, ie, angle at which each antenna is aimed relative to the horizon. PSITEO(1) is the main transmit antenna.
QCORR	R*4	GLO	Contains elements of covariance matrix, ie,

				powers and correlations.
	S	R*4	GLO	Troposcatter path asymmetry parameter.
	SCPARM	R*4	GLO	Wavenumber spectrum slope parameter M. Default is 3.66.
	STSNR	R*4	GLO	Standard deviation of troposcatter signal long-term SNR distribution in dB.
	THER	R*4	GLO	Radio horizon elevation angle at receive site in radians.
	THET	R*4	GLO	Radio horizon elevation angle at transmit site in radians.
	THETA0	R*4	GLO	Scattering angle at bottom of common volume.
	TODAY	L*1	GLO	Array used in PDP-11 version to hold date as characters.
	TROLOS	R*4	GLO	Median troposcatter path loss in dB for each value in ERFAC distribution.
	TRORSL	R*4	GLO	Median troposcatter RSL in dBm for each value in ERFAC distribution.
	UANGLE	R*4	GLO	Units of angle (deg, mrad).
	UDIST	R*4	GLO	Units of distance (smi, nmi, km).
	UFREQ	R*4	GLO	Units of frequency (GHz, MHz).
	UHITE	R*4	GLO	Units of height and diameter (ft, m).
	URV	R*4	GLO	Array of receive antennas vertical offsets.
	UTV	R*4	GLO	Array of transmit antennas vertical offsets.
TRC	(Subroutine) outputs to FOR002.DAT the following variables:			
	DAUX1	R*8	LOC	Implicit diversity eigenvalues for AN/TRC-170.
	ENMEAN	R*4	GLO	Average received energy.
	PAVG	R*4	GLO	Short-term average bit error rate for each sampling time and short-term average SNR.
	POUT	R*4	GLO	AN/TRC-170 outage probability and average bit error rate as a function of sampling time, short-term average SNR and error rate threshold.
	PYEAR	R*4	ARG	Yearly statistics. PYEAR(1,.) is yearly outage probability and PYEAR(2,.) is yearly fade outage probability per call minute for each BER threshold.
	SNDB	R*4	GLO	Signal to noise ratio in dB.
	SNRLOS	R*4	LOC	SNR loss in dB.
	TO	R*4	GLO	Normalized sampling time for lower beam.
	TOTO	R*4	GLO	Array of sampling times (normalized to symbol duration) for calculation of short term AN/TRC-170 performance.
	VEIGV	R*8	GLO	Implicit diversity eigenvalues for AN/TRC-170.
	X	R*4	LOC	Error rate threshold.
TRCIN	(Subroutine) outputs to FOR002.DAT the following variables:			
	BW99	R*4	LOC	
	CDUR	R*4	GLO	Duration of transmitted pulse for AN/TRC-170 normalized to signaling interval duration.

IPULS	I*2	GLO	Switch to indicate whether pulse shape at input of the AN/TRC-170 detector includes the effects of RF filters (IPULS = 2) or not (IPULS = 0 or 1). Set to 2
NCHIP	I*2	GLO	Number of chips in PN sequence used to expand bandwidth in AN/TRC-170.
NDIVS	I*2	GLO	Number of explicit diversity channels for AN/TRC-170. Equal to 4 for 2S/2F and 2 for 2S or 2F.
PEAKAV	R*4	GLO	Peak-to-average loss due to RF filtering in dB.
X	R*4	LOC	2*sigma multipath spread/symbol interval.

TROPO (Program) outputs to FOR002.DAT the following variables:

MRAD	I*2	GLO	Loop limit for MRAD. Default is 1. (MRAD is 1 for MDIST = 0 and MRAD is 3 for MDIST = 1).
NOW	L*1	GLO	Array used in PDP-11 version to hold time of day as characters.
NRAD	I*2	GLO	ERFAC indicator and loop counter. Default is 1.
TODAY	L*1	GLO	Array used in PDP-11 version to hold date as characters.

SUBPROGRAM INDEX

END

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